NASA

**Aerospace Medicine and Biology**
A Continuing Bibliography with Indexes

NASA SP-7011(292)
January 1987

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NASA SP-7011(292)

# AEROSPACE MEDICINE AND BIOLOGY

## A CONTINUING BIBLIOGRAPHY WITH INDEXES

## (Supplement 292)

A selection of annotated references to unclassified reports and journal articles that were introduced into the NASA scientific and technical information system and announced in December 1986 in

- *Scientific and Technical Aerospace Reports (STAR)*
- *International Aerospace Abstracts (IAA).*

NASA Scientific and Technical Information Branch 1987
**National Aeronautics and Space Administration**
Washington, DC

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# INTRODUCTION

This Supplement to *Aerospace Medicine and Biology* lists 192 reports, articles and other documents announced during December 1986 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA).* The first issue of the bibliography was published in July 1964.

In its subject coverage, *Aerospace Medicine and Biology* concentrates on the biological, physiological, psychological, and environmental effects to which man is subjected during and following simulated or actual flight in the Earth's atmosphere or in interplanetary space. References describing similar effects of biological organisms of lower order are also included. Such related topics as sanitary problems, pharmacology, toxicology, safety and survival, life support systems, exobiology, and personnel factors receive appropriate attention. In general, emphasis is placed on applied research, but references to fundamental studies and theoretical principles related to experimental development also qualify for inclusion.

Each entry in the bibliography consists of a bibliographic citation accompanied in most cases by an abstract. The listing of the entries is arranged by *STAR* categories 51 through 55, the Life Sciences division. The citations, and abstracts when available, are reproduced exactly as they appeared originally in *IAA* or *STAR,* including the original accession numbers from the respective announcement journals. The *IAA* items will precede the *STAR* items within each category.

Seven indexes — subject, personal author, corporate source, foreign technology, contract, report number, and accession number — are included.

An annual index will be prepared at the end of the calendar year covering all documents listed in the 1986 Supplements.

# TABLE OF CONTENTS


Page

**Category 51 Life Sciences (General)** 413
Includes genetics.

**Category 52 Aerospace Medicine** 417
Includes physiological factors; biological effects of radiation; and weightlessness.

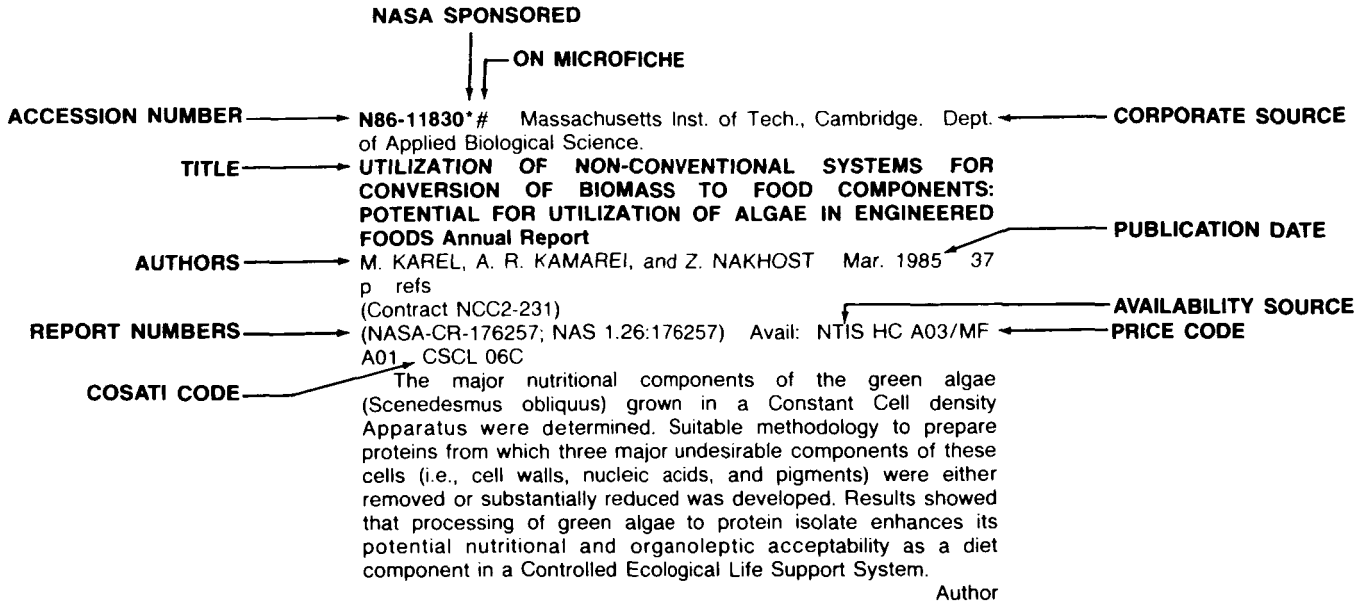
**Category 53 Behavioral Sciences** 426
Includes psychological factors; individual and group behavior; crew training and evaluation; and psychiatric research.

**Category 54 Man/System Technology and Life Support** 429
Includes human engineering; biotechnology; and space suits and protective clothing.

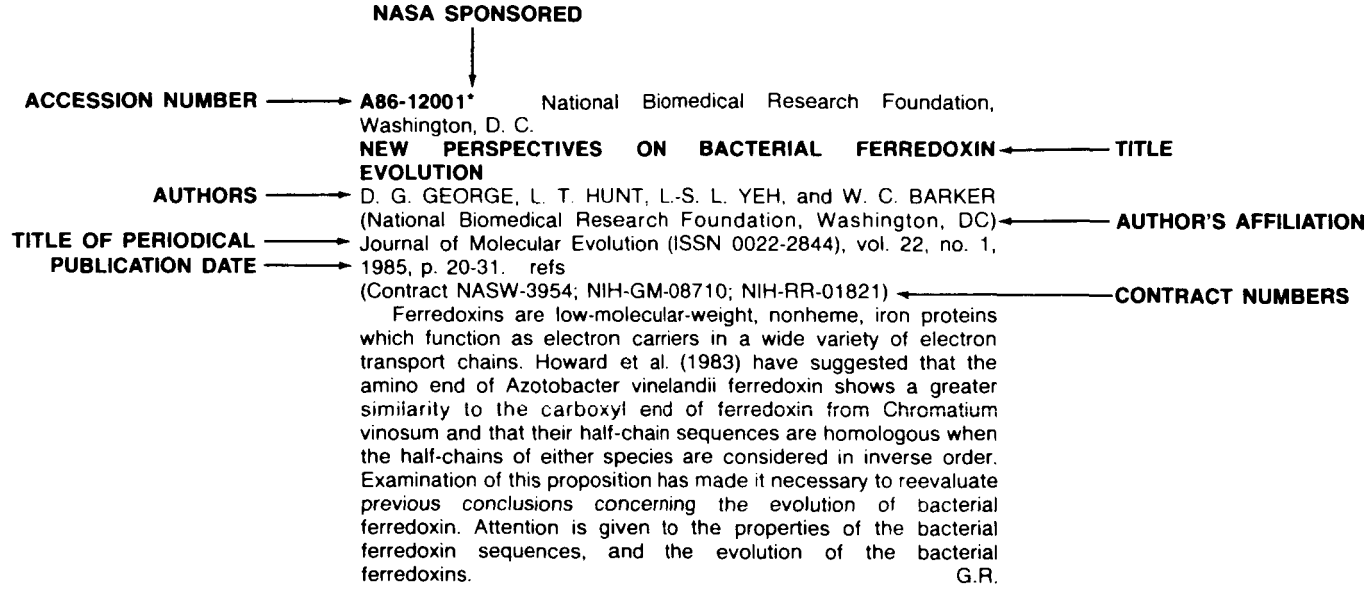
**Category 55 Planetary Biology** 444
Includes exobiology; and extraterrestrial life.

**Subject Index** ..... A-1
**Personal Author Index** ..... B-1
**Corporate Source Index** ..... C-1
**Foreign Technology Index** ..... D-1
**Contract Number Index** ..... E-1
**Report Number Index** ..... F-1
**Accession Number Index** ..... G-1

# TYPICAL REPORT CITATION AND ABSTRACT




# TYPICAL JOURNAL ARTICLE CITATION AND ABSTRACT



# AEROSPACE MEDICINE AND BIOLOGY

*A Continuing Bibliography (Suppl. 292)*

JANUARY 1987

## 51

## LIFE SCIENCES (GENERAL)

Includes genetics.

**A86-47869**
**EFFECT OF HYPOCAPNIA ON VENTRAL MEDULLARY BLOOD FLOW AND PH DURING HYPOXIA IN CATS**
D. G. DAVIES, W. F. NOLAN, and J. A. SEXTON (Texas Tech University, Lubbock) Journal of Applied Physiology (ISSN 0161-7567), vol. 61, July 1986, p. 87-90. refs
(Contract NIH-HL-25984)

Ventral medullary blood flow was measured in 33 chloralose-urethan-anesthetized cats during 60 min of isocapnia-hypoxia, mild hypocapnia-hypoxia, or severe hypocapnia-hypoxia. In an additional group of six animals the pH of ventral medullary extracellular fluid (ECF) was determined during mild hypocapnia-hypoxia. The increase in blood flow during hypoxia was reduced by mild hypocapnia and eliminated by severe hypocapnia. With the exception of an initial decrease in ECF H(+) concentration, which occurred during the first 10 min of mild hypocapnia-hypoxia, ECF H(+) concentration increased progressively throughout the exposure and recovery periods and was significantly elevated from the control value by the first 10 min of the recovery period. The results suggest that hypocapnia affects the hypoxic cerebrovascular response of the ventral medulla and that this phenomenon could affect the regulation of ventral medudllary ECF H(+) concentration. Author

**A86-47871*** London Univ. (England).
**EFFECT OF INACTIVITY AND PASSIVE STRETCH ON PROTEIN TURNOVER IN PHASIC AND POSTURAL RAT MUSCLES**
P. LOUGHNA (Tufts University, North Grafton, MA), G. GOLDSPINK (London, University, England), and D. F. GOLDSPINK (Belfast, Queen's University, Northern Ireland) Journal of Applied Physiology (ISSN 0161-7567), vol. 61, July 1986, p. 173-179. refs
(Contract NAG2-272)

Muscle atrophy in humans can occur during prolonged bed rest, plaster cast immobilization, and space flight. In the present study, the suspension model used by Musacchia et al. (1983) is employed to investigate changes in protein synthesis and degradation in fast-twitch phasic (extensor digitorum longus) and slow-twitch postural (soleus) muscles in the rat, following hypokinesia and hypodynamia. In addition, the use of passive stretch was examined as a means of preventing atrophy. The obtained results suggest that the mechanisms controlling the processes of protein synthesis and protein breakdown during muscle disuse atrophy may be independent of each other. It appears, however, that the muscle atrophy due to hypokinesia and hypodynamia can be temporarily prevented by passively stretching a muscle. G.R.

**A86-47872*** Management and Technical Services Co., Houston, Tex.
**AN ANALYSIS OF ESTIMATION OF PULMONARY BLOOD FLOW BY THE SINGLE-BREATH METHOD**
R. SRINIVASAN (Management and Technical Services Co., Houston, TX) Journal of Applied Physiology (ISSN 0161-7567), vol. 61, July 1986, p. 198-209. refs
(Contract NAS9-15850; NAS9-17133)

The single-breath method represents a simple noninvasive technique for the assessment of capillary blood flow across the lung. However, this method has not gained widespread acceptance, because its accuracy is still being questioned. A rigorous procedure is described for estimating pulmonary blood flow (PBF) using data obtained with the aid of the single-breath method. Attention is given to the minimization of data-processing errors in the presence of measurement errors and to questions regarding a correction for possible loss of CO2 in the lung tissue. It is pointed out that the estimations are based on the exact solution of the underlying differential equations which describe the dynamics of gas exchange in the lung. The reported study demonstrates the feasibility of obtaining highly reliable estimates of PBF from expiratory data in the presence of random measurement errors. G.R.

**A86-49155**
**THE EFFECT OF NORADRENALINE ON OXIDATION METABOLISM IN COLD-ADAPTED GOLDEN HAMSTERS [VLIIANIE NORADRENALINA NA OKISLITEL'NYI METABOLIZM U ZOLOTISTYKH KHOMIACHKOV, ADAPTIROVANNYKH K KHOLODU]**
L. S. MASLENNIKOVA (AN SSSR, Institut Fiziologii, Leningrad, USSR) Fiziologicheskii Zhurnal SSSR (ISSN 0015-329X), vol. 72, Feb. 1986, p. 246-252. In Russian. refs

**A86-49345**
**PROTON TRANSFER IN BACTERIORHODOPSIN [PEREBROS PROTONA V BAKTERIORODOPSINE]**
V. V. KRASNOGOLOVETS, N. A. PROTSENKO, and P. M. TOMCHUK Kiev, Institut Fiziki AN USSR, 1985, 28 p. In Russian. refs

A theory is presented to describe the entire transformation cycle of bacteriorhodopsin. The process of light-induced trans-cis isomerization in retinal is described, and a model Hamiltonian is presented for expressing the excitations evolving in the polyene chain. A mechanism of Schiff base deprotonation is proposed. I.S.

**A86-49346**
**PROTON EJECTION FROM BACTERIORHODOPSIN [EZHEKTSIIA PROTONA IZ BAKTERIORODOPSINA]**
V. V. KRASNOGOLOVETS, N. A. PROTSENKO, and P. M. TOMCHUK Kiev, Institut Fiziki AN USSR, 1985, 27 p. In Russian. refs

The transfer of the energy stored in the 13-cis-conformation of retinal into the exterior proton channel is discussed. The nonequilibrium function for the distribution of excitations of intramolecular oscillations has been determined for different moments of the transfer, including the moment of proton ejection into the external aqueous medium. A theory describing the functioning of an active proton channel is developed, together with a model Hamiltonian, and the speed of the proton transfer

through an active channel is calculated. This value is compared with the speed of a proton passing through a passive channel.
I.S.

**A86-49347**
**PROTON INJECTION INTO BACTERIORHODOPSIN [INZHEKTSIIA PROTONA V BAKTERIORODOPSIN]**
V. V. KRASNOGOLOVETS, N. A. PROTSENKO, and P. M. TOMCHUK Kiev, Institut Fiziki AN USSR, 1985, 9 p. In Russian. refs

Transformation of cis-retinal into its trans-isomer followed by proton capture by a Schiff base from the interior proton channel is described. This event leads to an injection of another proton into the interior channel from the aqueous cytoplasmic phase. The individual steps of the process include: (1) hydrolysis of a Schiff base (in the retinal's cis-conformation), a shift of the peripheral lys 216 towards the interior channel, and cis-trans isomerization of retinal; and (2) formation of a Schiff base and its protonation (in the retinal's trans-conformation) by a proton from the interior channel, and, finally, an injection of a proton into the channel from the aqueous phase of the cytoplasm. I.S.

**A86-49348**
**THE RETINAL CYCLE IN BACTERIORHODOPSIN [RETINALEVYI TSIKL BAKTERIORODOPSINA]**
V. V. KRASNOGOLOVETS, N. A. PROTSENKO, and P. M. TOMCHUK Kiev, Institut Fiziki AN USSR, 1985, 24 p. In Russian. refs

The one-to-one correspondence between the spectroscopically observable cyclic color changes in bacteriorhodopsin and its physicochemical transformations has been previously established by Krasnogolovets et al. (1985). In this paper, the physicochemical characteristics of various intermediates in the rhodopsin cycle are described. In addition, the effects of environmental factors, such as electric field, temperature, humidity, and light intensity, on the rhodopsin transformation are examined. I.S.

**A86-49367**
**THE MECHANISM OF THE ADAPTOGENIC EFFECT OF TOCOPHEROL IN PROLONGED COLD EXPOSURE [O MEKHANIZME ADAPTOGENNOGO EFFEKTA TOKOFEROLA PRI DLITEL'NOM DEISTVII KHOLODA]**
IU. P. SHORIN, V. G. SELIATSKAIA, N. G. KOLOSOVA, and V. IU. KULIKOV (Institut Klinicheskoi i Eksperimental'noi Meditsiny, Novosibirsk, USSR) Fiziologicheskii Zhurnal (Kiev) (ISSN 0201-8489), vol. 32, Mar.-Apr. 1986, p. 184-188. In Russian. refs

The mechanism of the protective effect of tocopherol (TP) supplement on the time of survival at -27 C was studied in cold-adapted (7 weeks at +5 C) and room-temperature-adapted rats. Daily intakes of TP did not change the survival time of rats kept at +20 C, but, in the cold-adapted rats, the TP supplements caused a significant increase of resistivity (from 4.8-h-long survival without TP to 8.5 h). The parameters of the liver lipid-peroxidation system (the concentrations of diene conjugates, NADPH-dependent glutathione peroxidase/reductase system, reduced glutathione, etc.) have indicated suppressed peroxidase activity in both groups of rats receiving TP. However, the TP intake has prevented corticosterone increases caused by cold adaptation in rats without TP. It is concluded that the activity of the antioxidation systems does not per se affect the resistance to cold. Instead, the TP is believed to effect a more economical type of corticosteroid regulation in the cold-adapted animals. I.S.

**A86-49368**
**CHANGES IN THE BLOOD COAGULATION SYSTEM OF RABBITS UNDER CONDITIONS OF ACUTE HYPOXIA AND SOME METHODS OF ITS CORRECTION [IZMENENIE SISTEMY GEMOKOAGULIATSII PRI OSTROI GIPOKSII U KROLIKOV I NEKOTORYE SPOSOBY EE KORREKTSII]**
V. V. BAKANSKAIA (Grodnenskii Gosudarstvennyi Meditsinskii Institut, Grodno, Belorussian SSR) Fiziologicheskii Zhurnal (Kiev) (ISSN 0201-8489), vol. 32, Mar.-Apr. 1986, p. 217-221. In Russian. refs

The effect of the combined administration of rheopolyglucine (i.v.) and nicotinic acid (i.m.) on hypoxia-induced hypercoagulation and formation of intravascular blood clots was studied in rabbits 'elevated' to a height of 8000-m in a decompression chamber. Pretreatment with the two drugs has prevented blood hypercoagulation and clot formation observed in nontreated animals. The treated animals have exhibited increased activities of the fibrinolytic enzyme system. In addition, the drugs have prevented hypoxia-effected decreases in blood heparin and increases in fibrinogen. I.S.

**A86-49524*** Santa Clara Univ., Calif.
**HALOBACTERIUM DENITRIFICANS SP. NOV. - AN EXTREMELY HALOPHILIC DENITRIFYING BACTERIUM**
G. A. TOMLINSON (Santa Clara, University, CA), L. L. JAHNKE, and L. I. HOCHSTEIN (NASA, Ames Research Center, Moffett Field, CA) International Journal of Systematic Bacteriology (ISSN 0020-7713), vol. 36, Jan. 1986, p. 66-70. refs

Halobacterium denitrificans was one of several carbohydrate-utilizing, denitrifying, extremely halophilic bacteria isolated by anaerobic enrichment in the presence of nitrate. Anaerobic growth took place only when nitrate (or nitrite) was present and was accompanied by the production of dinitrogen. In the presence of high concentrations of nitrate (i.e., 0.5 percent), nitrous oxide and nitrite were also detected. When grown aerobically in a mineral-salts medium containing 0.005 percent yeast extract, H. denitrificans utilized a variety of carbohydrates as sources of carbon and energy. In every case, carbohydrate utilization was accompanied by acid production. Author

**A86-49871*** Baylor Univ., Houston, Tex.
**DEVELOPMENT OF OTOCONIA IN THE EMBRYONIC CHICK (GALLUS DOMESTICUS)**
C. D. FERMIN and M. IGARASHI (Baylor University, Houston, TX) Acta Anatomica (ISSN 0001-5180), vol. 123, 1985, p. 148-152. Research supported by the McFadden Trust Research Fund. refs
(Contract PHS-RR-05425; PHS-NS-10940; NAG2-342)

In the chick (Gallus domesticus) embryo, otoconium formation started first over the macula sacculi around the 4th day of incubation, and a day later over the macula utriculi. It was determined that each otoconium formed as a result of the segmentation of the immature otolithic membrane, and that the calcium responsible for otoconium calcification was incorporated into the organic matrix of each otoconium in the form of small electron-dense granules (20-150 nm in. diameter). The presence of calcium in these granules was confirmed by histochemical staining with osmic-potassium pyroantimonate, by EDTA chelation, and by X-ray micronanalysis under the electron microscope.
Author

**A86-49921**
**THE ACTIVITY OF CHOLINESTERASE AND NOREPINEPHRINE AFTER LASER IRRADIATION OF ACUPUNCTURE POINTS [AKTIVNOST' KHOLINESTERAZY I NORADRENALINA PRI VOZDEISTVII NA TOCHKI AKUPUNKTURY LAZEROM]**
V. M. LUPYR and N. G. SERGIENKO (Khar'kovskii Meditsinskii Institut, Kharkov, Ukrainian SSR) Fiziologicheskii Zhurnal (Kiev) (ISSN 0201-8489), vol. 32, May-June 1986, p. 297-303. In Russian. refs

The effect of laser irradiation (for 10 days at 15, 30, or 60-sec/day doses) of acupuncture points (APs) in rats on the activity of acetylcholinesterase (ACE) and norepinephrine was

determined by postmortem analyses of these compounds in various body tissues. It was found that laser stimulation of APs causes an increase of norepinephrine in liver, but a decrease in the hepatoduodenal ligament, indicating a specific trophic effect on liver by the sympathetic nervous system in response to AP stimulation. Irradiation of APs was found to depress the ACE activity in the spinal neurons at all doses; but in the liver and duodenum, the relationships between the irradiation dose and the effect on ACE were complex. In liver, the ACE activity was seen to fall by 18 percent after a 15-sec dose, but after a higher dose, the activity rose again to above-normal levels. In the duodenum, the response to a 15-sec dose was an increase, by 60 percent, of the ACE activity, but after the two higher doses, the levels of the ACE activity were only slightly above normal. I.S.

**A86-49998**
**PHOTOACTIVE PIGMENTS IN HALOBACTERIA FROM THE GAVISH SABKHA**
W. STOECKENIUS, D. BIVIN, and K. MCGINNIS IN: Ecological studies. Volume 53 - Hypersaline ecosystems. Berlin, Springer-Verlag, 1985, p. 288-295.

The pigment-related properties of halobacteria strains isolated from brine and solid-salt samples collected in the Gavish Sabkha during August-November 1980-1982 are investigated experimentally by means of electron microscopy, flash and conventional absorption spectroscopy, and recording of light-dependent proton movement. The results are presented graphically and characterized in detail. Pigments similar to or identical with the bacteriorhodopsin, halorhodopsin, and sR pigments found in H. halobium (Stoeckenius et al., 1979) are identified and found to play dominant roles in the light responses of the halobacteria. The importance of such pigments as light-energy transducers in primitive bacteria, and thus theoretically in the origins of life on earth, is discussed. T.K.

**A86-49999*** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
**STRUCTURAL CORRELATES OF AGING IN DROSOPHILA - RELEVANCE TO THE CELL DIFFERENTIATION, RATE-OF-LIVING AND FREE RADICAL THEORIES OF AGING**
D. E. PHILPOTT (NASA, Ames Research Center, Moffett Field, CA) and J. MIQUEL IN: Insect aging. Berlin, Springer-Verlag, 1986, p. 117-129. refs

**A86-50271*** California Univ., San Francisco.
**THE RHODOPSIN-LIKE PIGMENTS OF HALOBACTERIA - LIGHT-ENERGY AND SIGNAL TRANSDUCERS IN AN ARCHAEBACTERIUM**
W. STOECKENIUS (California, University, San Francisco) Trends in Biochemical Sciences (ISSN 0376-5067), vol. 10, Dec. 1985, p. 483-486. refs
(Contract NIH-GM-27057; NSG-7151)

Three, small retinylidene proteins observed in halobacteria are described. The characteristics of bacteriorhodopsin (bR), which is synthesized during low O2 tension and intense illumination, and the role of bR in the cyclic photoreactions that translocate protons are examined. The detected light-driven chloride influx pigment, halorhodopsin (hR), is also capable of light-driven ion translocation; the hR transport reactions which are chloride dependent and involve isomerization are studied. The sensory photosystem of halobacteria and the receptor functions of the retinal pigment slow rhodopsin are discussed. The similarity of the choromphore structure and photoreactions, and the evolutionary relation between halobacteria and animal pigments are considered. I.F.

**A86-50288**
**BIOCHEMICAL RESPONSES OF XENOPUS LAEVIS MUSCLES TO CHANGES IN ENVIRONMENT. I. - COMPARISON TO RANA CATESBEIANA AND EXPOSURE TO GRAVIC ENVIRONMENT**
M. MASUDA, Y. OHIRA, and S. IKAWA (Jikei University, Tokyo, Japan) Japanese Journal of Aerospace and Environmental Medicine (ISSN 0387-0723), vol. 22, Oct. 1985, p. 33-39. refs

In connection with the conduction of manned space flight missions, various kinds of physiological responses of the human body to conditions of weightlessness have been reported, including a decrease in heart and skeletal muscle size and function. The present investigation is concerned with biological responses to weightlessness. In a simulation of weightlessness conditions in space, an underwater environment is utilized in the experiments. For this reason, Xenopus Laevis (Xenopus, South African clawed frog) living underwater was employed in the study together with Rana catesbeiana (Rana bullfrog) which is amphibious. Xenopus can also survive in air. The investigation had the objective to determine the effect which changes in living environment have on heart and gastrocnemius muscles. It was found that changes in living environment from underwater to land caused a significant alteration in metabolic profiles. However, it is not yet clear which factors are responsible for these changes. G.R.

**A86-50289**
**BIOCHEMICAL RESPONSES OF XENOPUS LAEVIS MUSCLES TO CHANGES IN ENVIRONMENT. II - RESPONSES TO GRAVITY AND PRESSURE**
Y. OHIRA, M. MASUDA, H. HASEGAWA, M. OHIRA, and S. IKAWA (Jikei University, Tokyo, Japan) Japanese Journal of Aerospace and Environmental Medicine (ISSN 0387-0723), vol. 22, Oct. 1985, p. 40-45. refs

Although atrophy of muscles as a result of space flight has been reported,the metabolic responses of muscles to weightlessness are still not understood. In studies conducted with Xenopus laevis, significant differences were found between animals kept underwater and in the air. An investigation was performed concerning the effects of various factors on metabolic characteristics of muscles, taking into account environmental pressure, PO2, and gravity. It was found that changes in environment from a hypogravic to a gravic one caused an alteration of enzyme activities. Responses to conditions involving 1G, 5G, and 308 torr, relative to results for a depth of 20 cm under water, were similar, and no significant effect of environmental pressure was observed. It is concluded that the major cause of the observed changes might be environmental gravity or muscle dynamics. G.R.

**A86-50290**
**EFFECTS OF -GZ CENTRIFUGAL ACCELERATION UPON CARDIAC OUTPUT OF HAMSTER**
H. SATAKE (Gifu University, Japan), S. WATANABE (Nagoya University, Japan), Y. MIZUNO (Daido Institute of Technology, Nagoya, Japan), and H. URANO (Fukui Medical School, Japan) Japanese Journal of Aerospace and Environmental Medicine (ISSN 0387-0723), vol. 22, Dec. 1985, p. 53-64. refs

The present investigation had the objective to determine the effect of a relatively long exposure of small animals to -Gz centrifugal acceleration, taking into account conditions in the cardiopulmonary system. In the experiment considered, cardiac output is studied quantitatively together with heart rate. Thirty-five golden hamsters (Mesocricetus auratus) were employed in the tests. The obtained results show that cardiac output decreases during -Gz acceleration exposure. In bilateral labyrinthectomized hamsters, the cardiac output decreased during -Gz exposure, and no significant difference was observed in comparison with the intact group. However, in the recovery phase, the difference of cardiac output between animals in the intact group and in the other group was significant. G.R.

**N86-32082#** Defence Research Information Centre, Orpington (England).
**EXTERNAL RESPIRATION, GAS EXCHANGE, AND BLOOD OXYGEN PARAMETERS IN ACUTE METHEMOGLOBINEMIA**
M. M. SEREDENKO, V. P. POZHAROV, and N. G. SIDORYAK Dec. 1985 13 p Transl. into ENGLISH from Fiziologicheskii Zhurnal (Kiev, USSR), v. 31, no. 3, 1985 p 262-266
(DRIC-T-7663; BR98339; ETN-86-97263) Avail: Issuing Activity

Hemic hypoxia in rats was studied. Subcutaneous injection of sodium nitrite into rats leads to development of pronounced hemic hypoxia, accompanied by inhibition of the external respiratory

function, decrease in oxygen consumption, and development of arterial hypoxemia. ESA

**N86-32083*#** Management and Technical Services Co., Washington, D.C.
**USSR SPACE LIFE SCIENCES DIGEST, ISSUE 7**
L. R. HOOKE, ed., M. RADTKE, ed., V. GARSHNEK, ed., R. TEETER, ed., and J. E. ROWE, ed. (Library of Congress, Washington, D. C.) Washington NASA Aug. 1986 113 p
(Contract NASW-3676)
(NASA-CR-3922(08); NAS 1.26:3922(08)) Avail: NTIS HC A06/MF A01 CSCL 06B

This is the seventh issue of NASA's USSR Space Life Sciences Digest. It contains abstracts of 29 papers recently published in Russian language periodicals and bound collections and of 8 new Soviet monographs. Selected abstracts are illustrated with figures and tables from the original. Additional features include two interviews with the Soviet Union's cosmonaut physicians and others knowledgable of the Soviet space program. The topics discussed at a Soviet conference on problems in space psychology are summarized. Information about English translations of Soviet materials available to readers is provided. The topics covered in this issue have been identified as relevant to 29 areas of aerospace medicine and space biology. These areas are adaptation, biospherics, body fluids, botany, cardiovascular and respiratory systems, developmental biology, endocrinology, enzymology, exobiology, genetics, habitability and environment effects, hematology, human performance, immunology, life support systems, mathematical modeling, metabolism, microbiology, morphology and cytology, musculoskeletal system, neurophysiology, nutrition, perception, personnel selection, psychology, radiobiology, and space medicine. Author

**N86-32084#** Texas Univ., Dallas. Center for communication Disorders.
**A CHINCHILLA RESTRAINT SYSTEM**
C. E. HARGETT, JR., J. H. PATTERSON, JR., D. L. CURD, M. CARRIER, JR., and I. M. L. GAUTIER Jan. 1986 25 p
(Contract DAMD17-80-C-0109; DA PROJ. 3M6-1102-BS-10)
(AD-A167408; USAARL-86-1) Avail: NTIS HC A02/MF A01 CSCL 06J

In studies of noise-induced hearing loss in chinchillas, it is necessary to restrain the animal in a known noise field for the duration of the exposure. In studies of continuous noise effects, a small cage in which the subject is free to move about has been used. The orientation of the subject due to the omnidirectional nature of continuous noise effects is not critical due to the omnidirectional nature of the exposure. In contrast, freefield impulse noise is a highly directional sound field by its essential nature. The need to restrain the research subject and fix its orientation relative to the source of the impulse is critical in impulse noise exposures. Only three references were found in the literature about chinchilla restraining devices. These devices were applicable more for routine clinical procedures, administering medication, detecting motion, and collecting motion, and collecting semen for reproduction studies. None were suited for auditory research. This led us to develop the chinchilla restraint system (CRSS). The function of the CRS is to maintain a chinchilla in a stable, immobile position which can be standardized for all subjects during studies of noise-induced hearing loss. The CRS accomplishes this using the chinchilla's own natural tendencies as a burrowing creature. The CRS provides an artificial burrow in which a chinchilla seems content to remain quiet for extended periods. This report details the design and use of the CRS. GRA

**N86-32085#** Nevada Univ., Reno. Desert Research Inst.
**GAS EXCHANGE CHARACTERISTICS OF LEAVES AS INDICATORS OF THE BASIC LIMITATIONS TO THE RATE OF PHOTOSYNTHESIS Annual Report, 1 Jun. 1985 - 31 May 1986**
T. D. SHARKEY 1986 4 p
(Contract DE-FG08-84ER-13234)
(DE86-009632; DOE/ER-13234/2; AR-2) Avail: NTIS HC A02/MF A01

The response of photosynthesis to light, CO2 and O2 is studied by measuring the exchange of gases (water vapor and CO2) between the atmosphere and the leaf. These measurements are combined with measurements of metabolite levels and enzyme activities which can disclose the molecular events which limit or regulate the rate of photosynthesis. The purpose of this research is to identify the underlying molecular events which give rise to easily measured photosynthetic characteristics so that those processes which are most important in regulating or limiting photosynthesis in leaves can be identified. A significant result of this research has been the identification of the cause of O2 insensitive photosynthesis in C3 plants. It has been determined that this anomalous behavior is caused by deactivation of the primary carboxylating enzyme, RuBP carboxylase, in low O2. It is believed that this deactivation occurs because the plant is unable to use all of the products of photosynthesis that could be made if deactivation did not occur. Current efforts are directed toward understanding how this deactivation may be advantageous to the plant and how rapidly it can occur. DOE

**N86-32086#** Florida State Univ., Tallahassee.
**GUARD CELL BIOCHEMISTRY: RESPONSE TO ENVIRONMENTAL STIMULI CAUSING CHANGES IN GAS EXCHANGE**
W. H. OUTLAW, JR. 1986 24 p
(Contract DE-AS05-81ER-10803)
(DE86-010287; DOE/ER-10803/5) Avail: NTIS HC A02/MF A01

Our understanding of how the light reactions of photosynthesis influence carbon metabolism in guard cells is rudimentary. This state of affairs is understandable; reliable reports of PS II in guard cells were published only two years ago. At this point, I wish to warn against complacency in drawing strict analogies between guard cell chloroplast function and that in other cells. In general, guard cell chloroplasts and their mesophyll counterparts differ in morphology, for example, the guard cell organelles are smaller, less abundant, and paler, have fewer thylakoids/granna, have areas of peripheral reticulum, and contain relatively more starch. One biochemical difference underlying these morphological ones has already been identified (fluorescence kinetics). DOE

**N86-32087#** European Space Agency, Paris (France).
**INFLUENCE OF GRAVITY ON STRUCTURE AND BEHAVIOR OF PARAMECIUM CAUDATUM**
R. HEMMERSBACH Mar. 1986 69 p Original language document was announced as N86-15863
(ESA-TT-963; DFVLR-FB-85-40; ETN-86-98077) Avail: NTIS HC A04/MF A01; German version avail. from DFVLR, Cologne, West Germany DM 27

Paramecium caudatum was used to study the behavior of the contractile vacuolar system, the nutrient uptake, cyclose, multiplication rate, and ultrastructure under simulated weightlessness using a fast-running clinostat and a modified agar method. In comparing 0 and 1 g behavior, no modification is detected, except for the vacuolar system. The slowed and irregular functioning behavior of the contractile vacuolar system due to an inner timing modification is influenced by gravity. Negative geotaxis of Paramecium caudatum is not confirmed. The effects of gravity on the vacuole formation, situation, and number cannot be determined. ESA

**N86-32950*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
**NASA WORKSHOP ON ANIMAL GRAVITY-SENSING SYSTEMS**
M. L. CORCORAN, ed. Aug. 1986 52 p Held at Pacific Grove, Calif., Feb. 1985
(NASA-TM-88249; A-86233; NAS 1.15:88249) Avail: NTIS HC A04/MF A01 CSCL 06C

The opportunity for space flight has brought about the need for well-planned research programs that recognize the significance of space flight as a scientific research tool for advancing knowledge of life on Earth, and that utilize each flight opportunity to its fullest. For the first time in history, gravity can be almost completely eliminated. Thus, studies can be undertaken that will help to elucidate the importance of gravity to the normal functioning of living organisms, and to determine the effects microgravity may have on an organism. This workshop was convened to organize a plan for space research on animal gravity-sensing systems and the role that gravity plays in the development and normal functioning of these systems. Scientists working in the field of animal gravity-sensing systems use a wide variety of organisms in their research. The workshop presentations dealt with topics which ranged from the indirect gravity receptor of the water flea, Daphnia (whose antennal setae apparently act as current-sensing receptors as the animal moves up and down in water), through specialized statocyst structures found in jellyfish and gastropods, to the more complex vestibular systems that are characteristic of amphibians, avians, and mammals. Author

**N86-32951#** Department of the Air Force, Washington, D.C.
***IN VIVO* DERMAL ABSORPTION METHOD AND SYSTEM FOR LABORATORY ANIMALS Patent**
J. N. MCDOUGAL, M. L. GARGAS, R. A. STROHAVER, G. W. JEPSON, and K. R. THIMLING, inventors (to Air Force) 15 Apr. 1986 8 p Supersedes AD-D011231
(AD-D012325; US-PATENT-4,582,055;
US-PATENT-APPL-SN-612776; US-PATENT-CLASS-128-202.12)
Avail: US Patent and Trademark Office CSCL 06K

A method and system for in vivo dermal absorption testing of a laboratory animal uses a mask and harness for protecting the respiratory tract of the animal when the animal is housed within a sealed chamber with a hazardous test vapor introduced in the chamber. Because of the difficulty of getting a good seal with a protective mask on a laboratory animal, this system is designed with an air leak from inside the mask into the chamber. To ensure that the test vapor does not infiltrate the mask nor leak from the chamber, the vapor is maintained at a negative pressure within the chamber as compared to the external atmospheric pressure and air is supplied to the mask for the animal to breathe at a positive pressure and at a greater rate than that needed by the animal. GRA

**N86-32952#** Brown Univ., Providence, R. I. Center for Neural Science.
**PERIPHERAL NERVE INJURY IN DEVELOPING RATS REORGANIZES MOTOR CORTEX**
J. P. DONOGHUE and J. N. SANES 19 May 1986 14 p
(Contract N00014-81-K-0136; PHS-1-R01-NS22517-01)
(AD-A168019; TR-29) Avail: NTIS HC A02/MF A01 CSCL 06E

The effect of neonatal nerve leisons on cerebral motor cortex organization was investigated by comparing the cortical motor representation of normal adult rats with adult rats that had one forelimb removed on the day of birth. Mapping of cerebral neocortex with electrical simulation revealed an altered relationship between the motor cortex and the remaining muscles. While distal forelimb movements are normally elicited at the lowest threshold in the motor cortex forelimb area, the same stimuli activated shoulder and trunk muscles in experimental animals. In addition an expanded cortical representation of intact body parts was present and there was an absence of a distinct portion of motor cortex. These data demonstrate that representation patterns in motor cortex are subject to environmental events that occur during development. GRA

**N86-32953#** Naval Aerospace Medical Research Lab., Pensacola, Fla.
**GROWTH AND DEVELOPMENT OF RHESUS MONKEYS EXPOSED TO ELF (EXTREMELY LOW FREQUENCY) ELECTRIC AND MAGNETIC FIELDS DURING THE FIRST 54 MONTHS OF LIFE Final Report, Oct. 1979 - Sep. 1984**
W. G. LOTZ, J. L. SAXTON, T. A. GRINER, and J. D. GRISSETT May 1986 62 p
(AD-A168733; NAMRL-1318) Avail: NTIS HC A04/MF A01 CSCL 06S

Thirty rhesus monkeys (Macaca mulatta), 17 males and 13 females, were exposed to 22 hours per day, 7 days per week, from 1 to 54 months of age to extremely low frequency (ELF) electric and magnetic fields. A second group of 30 animals served as controls. The project was designed to produce fields similar to, but stronger than those associated with the Navy's ELF communications system. The field parameters (0.2mT and 20 V/m at a frequency modulated between 72 and 80 Hz) were the same as those used in an earlier study in which enhanced growth rate occurred in pubescent male rhesus monkeys. The biological endpoints measured included body weight, bone growth, steroid hormones, hematology, and menstrual cycle data. No differences between exposed and control groups were observed prior to puberty. During puberty, body weight, bone growth, the age at which menarche was observed, and the progressive development of the mature endocrine rhythms of the menstrual cycle were all similar for both the exposed and control female monkeys. Body weight curves of the exposed and control males began to grow faster than the controls, and continued to diverge slowly through approximately 42 months of age. The growth curve separation narrowed, however, in the last 12 months of the study. The differences in growth were not statistically significant. No significant differences in mean testosterone levels of male monkeys were observed. GRA

# 52

# AEROSPACE MEDICINE

Includes physiological factors; biological effects of radiation; and weightlessness.

**A86-47729**
**VISIBILITY THRESHOLD RANGE OBSERVATIONS OF LED EMERGENCY EGRESS LIGHTING STRIPS AND SIGNS THROUGH DENSE SMOKE AND TURBID WATER**
H. G. GROSS (Wickes Manufacturing Co., Anaheim, CA) IN: SAFE Association, Annual Symposium, 23rd, Las Vegas, NV, December 1-5, 1985, Proceedings . Van Nuys, CA, SAFE Association, 1986, p. 34-40. refs

**A86-47741*** School of Aerospace Medicine, Brooks AFB, Tex.
**EVALUATION OF 9.5 PSIA AS A SUIT PRESSURE FOR PROLONGED EXTRAVEHICULAR ACTIVITY**
G. A. DIXON (USAF, School of Aerospace Medicine, Brooks AFB, TX) and R. KRUTZ (Technology, Inc., San Antonio, TX) IN: SAFE Association, Annual Symposium, 23rd, Las Vegas, NV, December 1-5, 1985, Proceedings . Van Nuys, CA, SAFE Association, 1986, p. 122-125.
(Contract NASA ORDER T-82170)

A study was undertaken to determine if a pressure of 9.5 psia would aid against the occurrence of decompression sickness in both males and females (without prebreathing or stage decompression requirements) during a typical simulated extravehicular activity scenario. Twenty percent of the male subjects produced grades 1 and 2 bubbles while females did not produce bubble signals at all. It is concluded that a pressure of 9.5 psia can protect the astronaut from both formation of severe bubbling and development of bends symptoms when exposed to these study conditions. K.K.

**A86-47753**
**DEVELOPMENT OF A MECHANICAL ANALOG OF A HUMAN SPINE AND VISCERA**
R. P. WHITE, JR. and B. P. MURPHY (Systems Research Laboratories, Inc., Dayton, OH) IN: SAFE Association, Annual Symposium, 23rd, Las Vegas, NV, December 1-5, 1985, Proceedings . Van Nuys, CA, SAFE Association, 1986, p. 201-209. refs

On the basis of experimental investigations conducted for many years, it has been observed that a seated human body, when subjected to time varying acceleration forces, rotates about its various points of articulation and the head/neck can undergo significant deformations and motions under the acceleration forces associated with ejection from an aircraft, these deformations of the spine, neck, and viscera cause time varying inertial forces and moments to be applied to the seat. These inertial forces can result in destabilizing moments which can cause the seat to tumble and rotate during the sustaining thrust sequence of ejection. For present day ejection seat systems with fixed sustainer rocket thrust angles, there is no realistic way to correct this problem. The duplication of these inertial forces by a mechanical analog of the human is important for evaluation of advanced ejection seats, such as CREST, which will use gimbaled rockets to stabilize the seat during ejection. The results of a recent internal research program conducted at Systems Research Laboratories, Inc. (SRL), to investigate means of duplicating the important dynamic responses of the spine and viscera in a manikin during ejection are presented. A proposed design of a flexible spine/viscera mechanical analog of their human counterparts is presented and discussed. Author

**A86-47754**
**A COMPARISON OF POSTURAL EQUILIBRIUM EFFECTS FOLLOWING EXPOSURE TO DIFFERENT GROUND-BASED FLIGHT TRAINERS**
R. S. KENNEDY, P. J. MERKLE, JR. (Essex Corp., Orlando, FL), and M. G. LILIENTHAL (U.S. Navy, Naval Training Systems Center, Orlando, FL) IN: SAFE Association, Annual Symposium, 23rd, Las Vegas, NV, December 1-5, 1985, Proceedings . Van Nuys, CA, SAFE Association, 1986, p. 210-213. refs

Ten different flight simulators were used to study the correlation between specific equipment features and the onset of traditional motion sickness, postural disequilibrium and disorientation. Results show that either a pilot's age or experience may increase susceptibility and that there is more eye strain with computer-generated images on CRTs than in dome projections. Shortening the hop length and adjusting the syllabus to gentler motions can lead to improvements. It is believed that this recent epidemic of simulator sickness can be attributed in part to increased simulator sophistication (ie. the capability to simulate more elaborate kinematics with greater realism and greater fidelity). As simulators become more representational, smaller perceptual nervous system tolerances may follow. K.K.

**A86-47765*** School of Aerospace Medicine, Brooks AFB, Tex.
**THE RELATIONSHIP OF INTRAVASCULAR BUBBLES TO BENDS AT ALTITUDE**
R. W. KRUTZ, G. A. DIXON, R. M. OLSON (Technology, Inc., San Antonio, TX), and A. A. MOORE (USAF, School of Aerospace Medicine, Brooks AFB, TX) IN: SAFE Association, Annual Symposium, 23rd, Las Vegas, NV, December 1-5, 1985, Proceedings . Van Nuys, CA, SAFE Association, 1986, p. 315-317. USAF-sponsored research. refs
(Contract NASA ORDER T-82170)

In response to recent findings attesting to a correlation between intravehicular bubbling and decompression sickness at intermediate altitudes, an attempt was made to define a minimum pressure for a pressure suit which would obviate the need for prebreathing 100 percent oxygen prior to extravehicular activity (EVA). Fifty-seven male subjects were exposed to altitudes ranging from 16,000 to 30,000 ft in two separate protocols. The first was designed to determine a pressure at which no bends occurred if a crewmember were decompressed from a sea level space station pressure just prior to EVA without prebreathing 100 percent oxygen. The other study was designed to define an altitude and exercise regimen at which bends-susceptible and bends-resistant crewmembers could be separated. It is shown that the close association which exists between severe bubbling and bends at a pressure altitude of 4.3 psia (30,000 ft) decreases as pressure is increased and essentially disappears at pressures less than or equal to 7.8 psia (16,000 ft). K.K.

**A86-47868**
**EFFECT OF PHYSICAL TRAINING IN HUMANS ON THE RESPONSE OF ISOLATED FAT CELLS TO EPINEPHRINE**
F. CRAMPES, M. BEAUVILLE, D. RIVIERE, and M. GARRIGUES (Toulouse, Universite, France) Journal of Applied Physiology (ISSN 0161-7567), vol. 61, July 1986, p. 25-29. refs

It has been shown that endurance training increases the oxidation potential of muscle tissue in animals and humans. Thus, the capacity to use fatty acids as substrates can be enhanced. In connection with a study of a possible adaptation of the metabolism of adipose tissue, an investigation was conducted regarding the question of whether the sensitivity to the lipolytic effect of epinephrine is modified in men undergoing training. Subcutaneous abdominal adipose tissue was selected for the experiments. The investigation involved a comparison of 10 marathon runners and 10 sedentary subjects. The obtained results show that lipolysis, induced in vitro by epinephrine using adipocytes from subcutaneous abdominal tissue, is significantly increased in endurance exercise-trained male subjects. G.R.

**A86-47870**
**ALDOSTERONE RESPONSE TO ANGIOTENSIN II DURING HYPOXEMIA**
G. L. COLICE (Dartmouth College; USVA, Medical Regional Office Center, White River Junction, VT) and G. RAMIREZ (James A. Haley Veterans Hospital; South Florida, University, Tampa, FL) Journal of Applied Physiology (ISSN 0161-7567), vol. 61, July 1986, p. 150-154. Research supported by the Kidney Research and Education Fund and USVA. refs
(Contract NIH-2-507-RR-05749)

Exercise stimulates the renin-angiotensin-aldosterone system (RAAS). However, increases in plasma aldosterone concentrations (PAC) are suppressed when exercise is performed at high altitude or under hypoxemic conditions. As the angiotensin-II response to high-altitude exercise is normal, it is speculated that an inhibitor, discharged during hypoxemia, acted to suppress angiotensin-II-mediated aldosterone release. A study was conducted to test this hypothesis, taking into account the measurement of the aldosterone response to exogenous angiotensin II during normoxemia and hypoxemia. It was found that the dose-response curve of PAC to angiotensin II was not significantly inhibited by the considered model of hypoxemia. The hypoxemia-mediated release of an angiotensin II inhibitor does, therefore, not explain the previous observations of PAC suppression during hypoxemic exercise. G.R.

**A86-47873**
**EFFECT OF NERVE BLOCK ON RESPONSE OF FOREARM BLOOD FLOW TO LOCAL TEMPERATURE**
C. B. WENGER, L. A. STEPHENSON, and M. A. DURKIN (John B. Pierce Foundation Laboratory; Yale University, New Haven, CT) Journal of Applied Physiology (ISSN 0161-7567), vol. 61, July 1986, p. 227-232. refs
(Contract NIH-ES-00354; NIH-HL-17732; NIH-T32-ES-507086)

Experiments were conducted with six healthy volunteers. The right arm (control) of a subject was exposed to ambient air, while the left forearm (experimental) was enclosed in a plastic bag, through which a controlled-temperature airstream was blown. The skin temperature of the experimental forearm (T/sk,e) was measured with thermocouples. Forearm blood flow (ABF) was measured bilaterally with Whitney mercury-in-silicone-rubber strain gages. Control and nerve block experiments were conducted. The results indicate that changes in ABF in the experimental arm (ABFe) were related to changes in T/sk,e rather than to any changes in

the thermoregulatory responses of the subject as a whole. On the basis of an evaluation of the experimental results, it is concluded that changes in local temperature affect forearm blood flow even in the absence of nervous signals, probably through a direct effect on vascular smooth muscle. G.R.

**A86-47874**
**PULMONARY GAS EXCHANGE IN HUMANS EXERCISING AT SEA LEVEL AND SIMULATED ALTITUDE**
P. D. WAGNER, G. E. GALE, R. E. MOON, J. R. TORRE-BUENO, B. W. STOLP (Duke University Medical Center, Durham, NC; California, University, La Jolla) et al. Journal of Applied Physiology (ISSN 0161-7567), vol. 61, July 1986, p. 260-270. Research supported by the American Lung Association and University of California. refs
(Contract NIH-HL-17731)

**A86-47875**
**NOCTURNAL PERIODIC BREATHING AT ALTITUDES OF 6,300 AND 8,050 M**
J. B. WEST, R. M. PETERS, JR., G. AKSNES, K. H. MARET, J. S. MILLEDGE (California, University, La Jolla) et al. Journal of Applied Physiology (ISSN 0161-7567), vol. 61, July 1986, p. 280-287. Research supported by the American Alpine Club, American Lung Association, Army, et al. refs
(Contract NIH-R01-HL-24335; NIH-N01-HR-2915)

The present paper provides a description of the patterns of nocturnal periodic breathing seen in members of the American Medical Research Expedition to Everest during several weeks residence at an altitude of 6,300 m (camp 2) and excursions to the highest camp at 8,050 m altitude. It is pointed out that the current study reports the highest measurements of nocturnal periodic breathing to date. All subjects were found to exhibit nocturnal periodic breathing at an altitude of 6,300 m. Seven of the eight subjects consistently showed apneic periods when breathing movements were at their minimum values. All four subjects studied at an altitude of 8,050 m showed cyclical variations in heart rate caused by periodic breathing. The study emphasizes the magnitude of the hypoxic insult which can be caused by periodic breathing at extreme altitude. G.R.

**A86-49225*** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
**EFFECT OF HYDRATION ON SOME ORTHOSTATIC AND HAEMATOLOGICAL RESPONSES TO HEAD-UP TILT**
M. H. HARRISON, L. C. HILL, W. A. SPAUL, and J. E. GREENLEAF (NASA, Ames Research Center, Moffett Field, CA) European Journal of Applied Physiology (ISSN 0301-5548), vol. 55, 1986, p. 187-194. refs

Experiments were undertaken to determine the effects of hydration status on: (1) orthostatic responses, and on (2) relative changes in intravascular volume and protein content, during 70 deg head-up tilt (HUT). Six men underwent 45 min of HUT, preceded by 45 min supine, first dehydrated, and again 105 min later after rehydration with water. Heart rate was consistently lower following rehydration (p less than 0.01), while supine diastolic pressure was higher (p less than 0.02). Systolic pressure fell during dehydrated HUT (p less than 0.01), but not during rehydrated HUT. Postural haemoconcentration, which was reduced after rehydration (p less than 0.001), was accompanied by a decrease in intravascular albumin content (p less than 0.05). Two subjects experienced severe presyncopal symptoms during dehydrated HUT, but not during rehydrated HUT. Thus, it appears that rehydration after fluid restriction improves orthostatic tolerance. Furthermore, extravascular hydration status may be more important than intravascular hydration status in determining orthostatic tolerance. Author

**A86-49250*** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
**METHOD OF HIGH-PRECISION MICROSAMPLED BLOOD AND PLASMA MASS DENSITOMETRY**
H. HINGHOFER-SZALKAY (NASA, Ames Research Center, Moffett Field, CA; Graz, Universitaet, Austria) Journal of Applied Physiology (ISSN 0161-7567), vol. 60, no. 3, 1986, p. 1082-1088. refs
(Contract FFWF PROJECT 3470; FFWF PROJECT 4200)

The reliability of the mechanical oscillator technique for blood and plasma density measurements on samples of volumes less than 0.1 ml is examined, and a precision of 0.001 g/l is found if plasma-isodensic heparin solution and siliconized densitometers are employed. Sources of measurement errors in the density determinations include storage of plasma samples, inhomogeneity of blood samples, and density reading before adequate temperature equilibration. In tests of plasma sample storage, the best reproducibility was obtained with samples kept at 4 C. Linear correlations were found between plasma density and plasma protein concentration, blood density and blood hemoglobin concentration, and erythrocyte density and MCHC. R.R.

**A86-49263**
**SPECTRAL-CORRELATION CHARACTERISTICS OF EEG IN THE COURSE OF SHORT-TERM MEMORY TESTS. I - A STUDY OF SPECTRAL-CORRELATION PARAMETERS OF THE POTENTIALS IN THE HUMAN NEOCORTEX DURING CORRECT SHORT-TERM MEMORIZING [SPEKTRAL'NO-KORRELIATSIONNYE KHARAKTERISTIKI EEG PRI TESTIROVANII NA KRATKOVREMENNUIU PAMIAT'. I - ISSLEDOVANIA SPEKTRAL'NO-KORRELIATSIONNYKH PARAMETROV POTENTSIALOV NEOKORTEKSO CHELOVEKA PRI PRAVIL'NOM KRATKOVREMENNOM ZAPOMINANII]**
IA. A. VASILEV, T. A. KOROLKOVA, and E. E. OSTROVSKAIA (AN SSSR, Institut Vysshei Nervnoi Deiatel'nosti i Neirofiziologii, Moscow, USSR) Fiziologiia Cheloveka (ISSN 0131-1646), vol. 12, May-June 1986, p. 355-360. In Russian. refs

**A86-49264**
**SPATIAL ORGANIZATION OF COMPONENTS OF THE VISUAL EVOKED POTENTIALS AND THE SENSORIMOTOR REACTION EFFICIENCY [PROSTRANSTVENNAIA ORGANIZATSIIA KOMPONENTOV ZRITEL'NYKH VYZVANNYKH POTENTSIALOV I EFFEKTIVNOST' SENSOMOTORNOI REAKTSII]**
V. P. ROZHKOV (AN SSSR, Institut Evoliutsionnoi Fiziologii i Biokhimii, Leningrad, USSR) Fiziologiia Cheloveka (ISSN 0131-1646), vol. 12, May-June 1986, p. 361-372. In Russian. refs

The temporal and spatial organization of components of the visual and evoked potentials (EPs) recorded during a period of intense attention preceding a light flash and the induced motor response, was studied in subjects aged 18-35 yr. The relationships between the speed of the motor reaction and the characteristics of the EP components' time and space organization were statistically analyzed using the method of Rozhkov (1982). The factors that reduced the reaction speed were found to be, for the initial component, the leading appearance of the EP wave in the occipital cortex area and, for the component immediately preceding the motor response, its original appearance in the central cortex. It is suggested that an area of appearance of leading EP waves corresponds with the zone of high excitability. I.S.

A86-49265
**THE USE OF CARDIAC-RHYTHM STATISTICAL CHARACTERISTICS IN EVALUATING MENTAL WORK CAPACITY [ISPOL'ZOVANIE STATISTICHESKIKH KHARAKTERISTIK SERDECHNOGO RITMA DLIA OTSENKI UMSTVENNOI RABOTOSPOSOBNOSTI]**
A. V. KARPENKO (Nauchno-Issledovatel'skii Institut Gigieny Truda i Profzabolevanii, Kiev, Ukrainian SSR) Fiziologiia Cheloveka (ISSN 0131-1646), vol. 12, May-June 1986, p. 426-431. In Russian. refs

The levels of mental work capacity were evaluated quantitatively by measuring cardiac-rhythm parameters in subjects performing operator-type mental activity. Caffeine or aminasin tablets were used to simulate elevated and depressed levels of mental activation, respectively. It has been established that the indices of the fluctuating cardiac-rhythm structure are highly sensitive to changes in mental productivity. I.S.

A86-49266
**POSSIBILITY OF OPTIMIZING RESPIRATORY ACTIVITY BY MEANS OF BIOCONTROL [O VOZMOZHNOSTI OPTIMIZATSII REAKTSII DYKHANIIA S POMOSHCH'IU BIOUPRAVLENIIA]**
A. M. SHMELEVA, A. V. KOCHUBEEV, and A. T. NORMATOV (AN SSSR, Institut Fiziologii, Leningrad, USSR) Fiziologiia Cheloveka (ISSN 0131-1646), vol. 12, May-June 1986, p. 432-437. In Russian. refs

The ability of man to compensate for alveolar hypocapnia, using instrumental feedback (biocontrol) has been investigated in seven tachypneic and two bradypneic male subjects. Hypocapnia was induced by means of an 'additional dead space' effected by inserting, (between the oxygen mask and the respiratory valves) an empty cylinder, which added 0.58 liter to the residual lung volume. Changes in respiration indices were registered automatically while the subjects were either breathing naturally or regulating their breathing arbitrarily by trying to maintain a preassigned level of CO2 pressure shown on their capnograms. A hypercapnic shift was averted by increasing the pulmonary ventilation. While the subjects of tachypnea type did this by increasing the respiratory volume, the bradypneic subjects increased ventilation by increasing the frequency of the respiratory cycles. I.S.

A86-49267
**CHANGES IN IMMUNITY UNDER STRESS [IZMENENIIA IMMUNITETA PRI STRESSE]**
I. D. SURKINA, Z. S. ORLOVA, G. S. ORLOVA, IU. B. BORODIN, S. K. DOBRINA (Vsesoiuznyi Nauchno-Issledovatel'skii Institut Fizicheskoi Kul'tury; Moskovskii Gosudarstvennyi Universitet, Moscow, USSR) et al. Fiziologiia Cheloveka (ISSN 0131-1646), vol. 12, May-June 1986, p. 460-464. In Russian. refs

The effect of combined physical and emotional stress on the activity of the T-immunity system was studied in 20 qualified ice skaters two months after completion of a long series of high-level competitions. The parameters of T-lymphocyte activity (formation of rosettes, lymphocytic blastotransformations) and the content of alpha-tocopherol in the lymphocytic plasma membranes were compared with the same parameters measured in subjects of a control group. The highly stressful physical and emotional activity was accompanied by suppression of both the immune reactions and the incorporation of alpha-tocopherol into the lymphocytic membrane (in spite of the normal levels of vitamin-E contents in blood). It is suggested that increased intake of vitamin E and regulation of the content of dietary polyunsaturated fatty acids may alleviate negative effects of stress on immunity. I.S.

A86-49268
**A QUICK METHOD FOR EVALUATING OPERATORS' WORK CAPACITY [EKSPRESS-METOD OTSENKI RABOTOSPOSOBNOSTI OPERATOROV]**
L. A. NECHAEVA, V. A. POLIANTSEV, and IU. S. NAZHIVIN (Moskovskii Meditsinskii Stomatologicheskii Institut; AN SSSR, Institut Psikhologii, Moscow, USSR) Fiziologiia Cheloveka (ISSN 0131-1646), vol. 12, May-June 1986, p. 469-475. In Russian. refs

Two types of indicators for estimating operator work capacity were correlated: (1) the indices of production, estimated according to the performance quality and the quantity of performed test assignments and (2) indices of physiological functioning, such as the values of cardiovascular parameters and the speed of sensory reaction. It was found that the magnitude of pulse frequency and the pulse stability are the most adequate correlators of the operator performance. The method is quick, easy, and can be applied without interrupting the operator's activity. I.S.

A86-49269
**SEASONAL AND CIRCADIAN RHYTHMS IN ANDROGEN EXCRETION IN THE EXTREMELY CONTINENTAL CLIMATE OF TRANS-BAIKAL AND THE BAM REGION AMONG GROUPS OF LOCAL NONNATIVE POPULATION [SEZONNYE I TSIRKADNYE RITMY EKSKRETSII ANDROGENOV V USLOVIIAKH REZKO KONTINENTAL'NOGO KLIMATA ZABAIKAL'IA I RAIONA BAM V GRUPPAKH MESTNOGO PRISHLOGO NASELENIIA]**
V. L. EILBART (Chitinskii Meditsinskii Institut, Chita, USSR) Fiziologiia Cheloveka (ISSN 0131-1646), vol. 12, May-June 1986, p. 483-488. In Russian. refs

Seasonal and circadian variations in the amounts of excreted 17-ketosteroids were studied in two groups: 247 men living in Chita (the control group) and in 116 nonnative men living since birth in the Kalarskii district of the northern Trans-Baikal region, characterized by an extremely continental climate and late springs. Compared with the values in the fall, which were similar in both groups, all subjects exhibited a drop in androgen excretion during both winter and summer. However, while in the control subjects the spring was the season of the highest androgen levels, the men of the Kalarskii district exhibited excretion levels which were lower in spring than in autumn, although higher than in winter and summer. Circadian rhythms were similar in the subjects of both groups, and were characterized by two maxima: one between 2 and 6 PM, and the other between 3 and 6 AM. It is considered that normalization of the seasonal and circadian hormonal rhythms in the newly arriving workers may speed up the adaptation process of the newcomers. I.S.

A86-49270
**THE USE OF A CONSTITUTIONAL APPROACH IN THE EVALUATION OF HEALTH STATUS [ISPOL'ZOVANIE KONSTITUTSIONAL'NOGO PODKHODA PRI OTSENKE SOSTOIANIIA ZDOROV'IA]**
S. V. KAZNACHEEV and S. V. UDALOVA (Institut Klinicheskoi i Eksperimental'noi Meditsiny, Novosibirsk, USSR) Fiziologiia Cheloveka (ISSN 0131-1646), vol. 12, May-June 1986, p. 489-494. In Russian. refs

A scheme for classifying individuals according to their reactions to graded physical loads is suggested, in which ergographic, dynamometric, and stepergometric measurements serve as means of evaluation. Correlating these reactions with physiological, hematological, and biochemical parameters measured in human subjects, two polar functional types of individuals were identified. Individuals of the 1st group, characterized by higher strength but lower endurance levels (the 'sprinters') exhibited lower lung capacity, somewhat lower values of blood sugar and blood lipids, higher ECG PQ intervals, and, in particular, lower salivary potassium levels. In addition the subjects in the sprinter group have performed more effectively and faster during a short-term stressful psychophysiological test, than did the subjects of the second group. The classification scheme can be applied in evaluations of general health status and in designing preventive measures. I.S.

**A86-49271**
**FUNCTIONAL STATE OF THE PANCREAS UNDER CONDITIONS OF PROLONGED BED REST [FUNKTSIONAL'NOE SOSTOIANIE PODZHELUDOCHNOI ZHELEZY PRI DLITEL'NOM POSTEL'NOM REZHIME]**
K. V. SMIRNOV, L. G. RUVINOVA, I. L. MEDKOVA, T. IA. STRUCHKOVA, and M. IA. TOLMACHEVA Fiziologiia Cheloveka (ISSN 0131-1646), vol. 12, May-June 1986, p. 499-502. In Russian. refs

The effect of prolonged antiorthostatic hypokinesia on the physical condition of the pancreas and its exocrine activity was studied on six healthy men, 32-46 years of age, kept for 120 days in bed with a head-down tilt of 4.5 deg. The functional state of the pancreas was evaluated from periodic analyses of pancreatic amylase, trypsin, and lipase in duodenal juice, blood serum, and urine and from ultrasonic scans of the gland. By the end of the 68th to the 89th day, all three enzymatic activities in the duodenal juice decreased sharply, while the activities in the serum increased significantly; urine values changed little. Pancreatic scans revealed the presence of parenchymal edema. The observed changes, which all normalized after the subjects resumed normal activity, can be characterized as a compensated pancreatic insufficiency caused, in part, by edema due to the redistribution of fluid in the upper body. I.S.

**A86-49272**
**THE FREQUENCY OF SISTER CHROMATID EXCHANGES IN BLOOD CELLS UNDER PROLONGED HYPOKINESIA [CHASTOTA SESTRINSKIKH KHROMATIDNYKH OBMENOV V KLETKAKH KROVI PRI DLITEL'NOI GIPOKINEZII]**
N. N. BOBKOVA Fiziologiia Cheloveka (ISSN 0131-1646), vol. 12, May-June 1986, p. 503-506. In Russian. refs

The mutagenic effect of prolonged hypokinesia and the protective effect of exercise were studied by counting the frequency of sister chromatid exchanges in the blood lymphocytes of two groups of subjects. The first group (three subjects) was kept in bed with a -5 deg tilt for 120 days without exercise, while the second bed-confined group (four subjects) was subjected daily to a special isokinetic training program. The sister chromatid exchanges were counted in 30 lymphocytic cells, found in the metaphase stage, from blood drawn before and after the 120-day-long regimens. While the subjects in the no-exercise group exhibited a significant ($p$ = less than 0.05) increase in the number of chromatid exchanges, no statistically significant increases were observed in the subjects subjected to a physical load during the bed-rest period. I.S.

**A86-49273**
**EEG CORRELATES IN THE PROCESS OF FORMING DRIVING SKILLS [ELEKTROENTSEFALOGRAFICHESKIE KORRELIATSII PROTSESSA FORMIROVANIIA NAVYKOV UPRAVLENIIA AVTOTRANSPORTNYM SREDSTVOM]**
V. I. BARTELS, P. P. SELTSOVSKII, and B. V. PEROV (Vsesoiuznyi Nauchno-Issledovatel'skii Institut Bezopasnosti Dorozhnogo Dvizheniia; Tsentral'nyi Nauchno-Issledovatel'skii Institut Refleksoterapii, Moscow, USSR) Fiziologiia Cheloveka (ISSN 0131-1646), vol. 12, May-June 1986, p. 516-518. In Russian.

The usefulness of the compressed spectral EEG analysis for evaluating the progress of a complex sensorimotor learning process was investigated by analyzing EEG power spectra of 12 right-handed men, with no previous driving experience, who were undergoing training on an AT-75 simulator. The time of passing the 'route', the number of errors, and the character of errors were correlated with the characteristics of EEG power spectra taken before, during, and after 10 attempts of route passage. It has been found that in the slow-learners, there was an increase in the frequency of the alpha-rhythm peak, accompanied by decreases in power in both hemispheres. The fast-learning subjects exhibited an interhemispheric power asymmetry in the alpha-rhythm interval, as well as periodic changes in the sign of power asymmetry. I.S.

**A86-49339**
**DYNAMICS OF THE CUPULA IN THE SEMICIRCULAR CANAL OF THE VESTIBULAR ANALYZER [DIAMIKA KUPULY V POLUKRUZHNOM KANALE VESTIBULIARNOGO ANALIZATORA]**
A. V. KONDRACHUK and S. P. SIRENKO Kiev, Institut Fiziki AN USSR, 1985, 24 p. In Russian. refs

A mathematical model is proposed for the cupuloendolymphatic system (CES) (i.e., the system of semicircular canals registering angular accelerations) of the vestibular analyzer (VA). Based on a simple model of the CES structure, an equation is obtained for calculating the dynamics of the system, which is then linked with Steinhausen's (1933) cupula model. It is shown that even small differences between the densities of lymph and the cupula can change the cupula dynamics significantly. These changes might affect the VA's functioning under conditions of repeatedly changing environment and gravity. I.S.

**A86-49370**
**ERGOMETRIC EXAMINATION OF THE CARDIOVASCULAR SYSTEM IN FLIGHT PERSONNEL [ISSLEDOVANIE SERDECHNO-SOSUDISTOI SISTEMY METODOM ERGOMETRII U LITS LETNOGO SOSTAVA]**
G. I. DOROFEEV and S. N. AKIMOV Voenno-Meditsinskii Zhurnal (ISSN 0026-9050), March 1986, p. 35-38. In Russian. refs

The functional status of normal and deficient cardiovascular systems was evaluated by analyzing the results of bicycle ergometer tests obtained on ten healthy pilots (for control values) and 57 pilots suffering from pathological conditions of the cardiovascular system of various degrees of severity. The parameters of work capacity were correlated with hemodynamic indices and with the severity of the pathological conditions. Compared with controls, most subjects suffering from cardiovascular abnormalities were found to have lower work capacity and unfavorable hemodynamic indices. Thus, in these subjects, the magnitudes of the stress index and the cardiac load index were higher than in control subjects, while the values of maximal oxygen consumption, heart output, and increases in stress index and heart rate were lower. The magnitudes of the observed changes correlated well with the severity of the pathological condition, and were maximal in subjects suffering from latent chronical ischemia. I.S.

**A86-49523*** Graz Univ. (Austria).
**FLUID AND PROTEIN SHIFTS AFTER POSTURAL CHANGES IN HUMANS**
H. HINGHOFER-SZALKAY (Graz, Universitaet, Austria) and M. MOSER (NASA, Ames Research Center, Moffett Field, CA) American Journal of Physiology: Heart and Circulatory Physiology (ISSN 0363-6135), vol. 19, 1986, p. H68-H75. refs
(Contract FFWF PROJECT 4200)

The effects of head-up, one-step, slow-graded, and rapid-graded tilt positions on blood density (BD), plasma density (PD), and erythrocyte density (ED) in male and female subjects are evaluated using a mass density detection method. The preparation of the samples and procedures for density and hematocrit measurements are described. The formula for calculating the density and volume of fluid shifted between intravascular and extravascular compartments is derived. The data reveal that ED does not change with varying tilt positions; however, PD and BD increase linearly with increasing angles of tilt, thereby resembling the time course of hemodilution and hemoconcentration. I.F.

**A86-49560#**
**OPERATIONAL MEDICAL PLANNING FOR SPACE STATION**
R. J. LUCIANI and E. PIERCE (Lovelace Medical Foundation, Albuquerque, NM) AIAA, Space Station in the Twenty-first Century, Meeting, Reno, NV, Sept. 3-5, 1986. 11 p.
(AIAA PAPER 86-2337)

The requirements for the Health Maintenance Facility of the Space Shuttle are examined using ground-based models. Data collected from the Antarctic station and Polaris submarines are studied with consideration given to habitability, human adaptation,

and isolation. Remote rural clinics provide information on the incidence of clinical problems, and equipment and training for the care of the illness. The specific space-related difficulties of radiation, bends, hypoxia, nephrolithiasis, muscle and cardiovascular deconditioning, skeletal calcium loss, and propellant toxic hazards are considered in terms of screening, diagnosis, and therapy. I.F.

**A86-49636*#** Veterans Administration Hospital, San Diego, Calif.
**NONLINEAR MECHANISMS IN PHYSIOLOGY AND PATHOPHYSIOLOGY TOWARD A DYNAMICAL THEORY OF HEALTH AND DISEASE**
A. L. GOLDBERGER (USVA, Medical Center; California, University, La Jolla), B. J. WEST (La Jolla Institute, CA), and V. BHARGAVA (USVA, Medical Center, La Jolla, CA) International Association for Mathematics and Computers in Simulation, World Congress on System Simulation and Scientific Computation, 11th, Oslo, Norway, Aug. 5-9, 1985, Paper. 4 p. Research supported by Cardiac Pacemakers, Inc., La Jolla Institute, and NASA. refs

The application of nonlinear analysis both to normal physiological dynamics and pathophysiological perturbations in a variety of different systems leads to observations not predicted by traditional models. Such analyses may have important implications for diagnostic and prognostic assessment as well as for therapeutics. Author

**A86-49919**
**EFFECTS OF HYPODYNAMIA AND NEUROEMOTIONAL STRESS ON THE PERFORMANCE OF CIRCULATORY AND RESPIRATORY SYSTEMS DURING MUSCULAR WORK [VLIIANIE GIPODINAMII I NERVNO-EMOTSIONAL'NOGO NAPRIAZHENIIA NA FIZICHESKUIU RABOTOSPOSOBNOST' SISTEM KROVOOBRASHCHENIIA I DYKHANIIA PRI MYSHECHNOI RABOTE]**
A. O. NAVAKATIKIAN, V. A. BUZUNOV (Institut Gigieny Truda i Profzabolevanii, Kiev, Ukrainian SSR), W. THIELE, and H. FRENZEL (Greifswald, Universitaet, East Germany) Fiziologicheskii Zhurnal (Kiev) (ISSN 0201-8489), vol. 32, May-June 1986, p. 278-284. In Russian. refs

**A86-49920**
**CORRELATIONAL RHYTHMOGRAPHY APPLIED TO PERSONS OF DIFFERENT AGE UNDER FUNCTIONAL LOADS [KORRELIATSIONNAIA RITMOGRAFIIA PRI FUNKTSIONAL'NOI NAGRUZKE U LITS RASNOGO VOZRASTA]**
A. L. RESHETIUK, V. L. BAKALEINIKOVA, and A. A. POLIAKOV (Institut Gerontologii, Kiev, Ukrainian SSR) Fiziologicheskii Zhurnal (Kiev) (ISSN 0201-8489), vol. 32, May-June 1986, p. 284-288. In Russian. refs

Correlation scattergrams of cardiac rhythms were registered by means of a rhythmocardioscope in the initial, load, and recovery periods of mental work (addition of double-digit numbers mentally) performed by healthy males, whose occupation involves physical work, of three age groups: 20-29 yr, 48-59 yr, and 60-75 yr. It was found that magnitudes of heart rate in the initial period of mental work were significantly lower in the older men than in the younger ones. Based on the initial scattergram data, three types of cardiac rhythm regulation were distinguished: sympathicotonic (predominating among the youngest men), normotonic, and parasympathicotonic (predominating among older men). The individual scattergram analysis during the initial, load, and recovery periods led to the identification of three types of response to mental loads depending on the typological reactivity characteristics of the subjects. I.S.

**A86-49975**
**ON THE INTERRELATIONSHIP BETWEEN DIFFERENT RANGES OF BIOELECTRIC ACTIVITY OF THE HUMAN BRAIN [K VOPROSU O VZAIMOSVIAZI MEZHDU RAZLICHNYMI DIAPAZONAMI BIOELEKTRICHESKOI AKTIVNOSTI GOLOVNOGO MOZGA CHELOVEKA]**
S. V. MEDVEDEV and M. A. BELOV (Nauchno-Issledovatel'skii Institut Eksperimental'noi Meditsinyi; Leningradski Nauchno-Issledovatel'skii Vychislitel'nyi Tsentr, Leningrad, USSR; Mezhvedomstvennyi Nauchnyi Sovet po Probleme Soznanie, Moscow, USSR) Akademiia Nauk SSSR, Doklady (ISSN 0002-3264), vol. 287, no. 6, 1986, p. 1509-1512. In Russian. refs

Experiments were conducted on patients with parkinsonism in an effort to establish a relationship between patterns of slow (Delta wave) and ultraslow physiological processes and neuron impulse activity (NIA) in the human brain during the performance of psychological tests. Brain-implanted microelectrodes made it possible to record the NIA, tau waves in the decasecond range, and waves in the 0.1-4 Hz range (called zeta Delta waves). Results indicate that there is a significant correlation between processes occurring in the tau and zeta Delta ranges and the behavior of the NIA current frequency. B.J.

**N86-32088*** National Aeronautics and Space Administration, Washington, D.C.
**AEROSPACE MEDICINE AND BIOLOGY: A CONTINUING BIBLIOGRAPHY WITH INDEXES (SUPPLEMENT 288)**
1986 69 p
(NASA-SP-7011(288); NAS 1.21:7011(288)) Avail: NTIS HC A05 CSCL 06E

This bibliography lists 190 reports, articles and other documents introduced into the NASA scientific and technical information system in August 1986. Author

**N86-32089#** Technion - Israel Inst. of Tech., Haifa.
**A 24-HOUR STRUCTURE OF VIGILANCE UNDER PROLONGED SLEEP DEPRIVATION: RELATIONSHIP WITH PERFORMANCE Final Report, Feb. 1983 - Feb. 1984**
P. LAVIE Mar. 1986 72 p
(Contract DAJA45-83-C-0047; DA PROJ. 2Q1-61102-B-74-D)
(AD-A167399; ARI-RN-86-32) Avail: NTIS HC A04/MF A01 CSCL 06S

The present study investigated the 36h structure of sleepiness and its relationship with psychomotor performance after 28h of sleep deprivation. Eight subjects, aged 19 to 25 years, participated after spending two adaptation nights in the sleep lab at 2300 and remained deprived of sleep until 1100. At 1100 a schedule of either 7 min sleep attemp in bed, 13 min awake outside the bedroom, or 7 min resisting sleep in bed, 13 min awake outside the bedroom, was begun and maintained for 36h until 23h on the next day. The order of the two experimental conditions, which were separated by two weeks, was counterbalanced. Polyhypnographic recordings were carried out during the 7-min in bed periods, and psychomotor testing (one and two-handed reaction time tasks) was conducted in the middle of the 13-min wake periods. Significant circadian effects were found for the two components of the psychomotor performance: reaction time and movement time. In spite of the great similarity between the circadian variations in sleepiness and the circadian variations in performance, correlating these two variables for 12h blocks revealed random and nonsignificant correlations. This negated a causal relationship between the amount of sleepiness and performance, and suggests that both are modulated by a common underlying circadian oscillator. GRA

**N86-32090#** Aerospace Medical Div., Brooks AFB, Tex.
**AIR FORCE TECHNICAL OBJECTIVE DOCUMENT, AEROSPACE MEDICAL DIVISION, FY 1987 Annual Report, Jun. 1985 - Jan. 1986**
Jan. 1986 25 p
(AD-A167422; AMD-TR-86-001) Avail: NTIS HC A02/MF A01 CSCL 05H

This TOD describes the planning methodology used within two of AMD's laboratories to achieve our technical goals. Specifically, efforts are directed in the biotechnology program to man's adaptability, survivability, and performance capabilities within his operational environment. This research and development of AMD's functions is accomplished as interdisciplinary work by teams of biomedical scientists, engineers, and physical scientists within the Air Force laboratories and the industrial and academic communities. GRA

**N86-32091#** Army Research Inst. of Environmental Medicine, Natick, Mass.
**ALTITUDE ACCLIMATIZATION (VENTILATION AND CHEMORESPONSIVENESS) DURING WAKEFULNESS AND SLEEP**
D. P. WHITE, K. GLEESON, C. K. PICKETT, J. T. REEVES, and A. M. RANNELS Apr. 1986 29 p
(AD-A167738; USARIEM-M-28/86) Avail: NTIS HC A03/MF A01 CSCL 06S

Although the influence of altitude acclimatization on respiration has been carefully studied, the associated changes in hypoxic and hypercapnic ventilatory responses are the subject of controversy and neither response has been carefully evaluated during sleep at altitude. To answer these questions, six healthy males were studied at sea level and on nights 1, 4, and 7 following arrival at altitude (14,110 ft). During wakefulness ventilation and the ventilatory responses to hypoxia and hypercapnia were determined on each occasion. During both NREM and REM sleep at sea level and on all three nights at altitude, ventilation and the hypercapnic ventilatory response were measured. With acclimatization to high altitude, ventilation increased during both wakefulness and sleep which reflected primarily increasing respiratory frequency. The slope of the hypercapnic response did not rise further with acclimatization although the position of this response shifted significantly to the left during wakefulness and sleep. Finally, sleep induced similar decrements in both ventilation and hypercapnic responsiveness at altitude to those seen at sea level. GRA

**N86-32092#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**SPECIAL FEATURES OF SURGICAL INTERVENTION UNDER CONDITIONS OF WEIGHTLESSNESS**
G. L. YAROSHENKO, V. G. TERENTYEV, and M. N. MOKROV 7 May 1986 11 p Transl. into ENGLISH from Voyenno-Meditsinskiy Zhurnal (USSR), no. 10, Oct. 1967 p 69-70
(AD-A167916; FTD-ID(RS)T-0294-86) Avail: NTIS HC A02/MF A01 CSCL 22A

At present questions of medical support of prolonged space flights acquire fundamental importance. Among these questions together with forecasting of the probable morbidity of cosmonauts urgent/actual is the determination of the possibility of executing of medical manipulations, including surgical intervention under the conditions of weightlessness. It is possible to make following conclusions: Execution of surgical intervention under conditions of weightlessness is possible and is not connected with great difficulties; The probability of pulverizing/atomizing biological fluids, which are located under relatively greater pressure (for example, arterial blood) should be considered; For preventing the pollution/contamination of the atmosphere of the cab during the dissection of tissues, rich in vessels, it is desirable to use hemostatic forceps. Local anesthesia in null gravity is shown. With autopsy of peritoneum strengthening of eventration of intestine is observed. Therefore the autopsy of peritoneum should be conducted step by step, minimally limiting the length of section/cut. With the filling of a syringe with medical solutions, intended for intravenous introduction, one should thoroughly track so that together with solution the air would not fall. GRA

**N86-32093#** National Aerospace Medical Centre, Soesterberg (Netherlands).
**ACTIVITIES REPORT ON PHYSICAL AND PSYCHOLOGICAL HEALTH OF FLYING PERSONNEL Annual Report, 1983 [JAARVERSLAG 1983]**
1984 45 p In DUTCH
(ETN-86-97385) Avail: NTIS HC A03/MF A01

Activities concerning the physical and psychological health of flying personnel are summarized. A human centrifuge; anthropometric measurements on adolescents; F-16 pilot EEG's; and motion perception sensations with peripherically offered visual stimuli are discussed. Research was done on Meniere patients and rheo-encephalographics. Computerized psychodiagnostic methods for pilot and driver aptitude judgements were developed. Airbus cockpit certification methods were evaluated. ESA

**N86-32094#** National Aerospace Medical Centre, Soesterberg (Netherlands).
**ACTIVITIES REPORT ON PHYSICAL AND PSYCHOLOGICAL HEALTH OF FLYING PERSONNEL Annual Report, 1984 [JAARVERSLAG 1984]**
1985 39 p In DUTCH
(ETN-86-97386) Avail: NTIS HC A03/MF A01

Activities concerning the physical and psychological health of flying personnel are summarized. A hybobaric chamber and human centrifuge are described. Prevention of blood pressure increase of pilots was examined. Possibilities of the body to increase acceleration tolerance, and relevant training mechanisms, were studied. Studies on vision and hearing were carried out. A psychodiagnostical investigation and test method useful for drivers was developed. ESA

**N86-32954** Groningen Rijksuniversiteit (Netherlands). Traffic Research Center.
**ZOPICLONE'S RESIDUAL EFFECT UPON ACTUAL DRIVING PERFORMANCE VERSUS THOSE OF NITRAZEPAM AND FLUNITRAZEPAM**
E. R. VOLKWERTS, J. W. LOUWERENS, A. B. M. GLOERICH, K. A. BROOKHUIS, and J. F. OHANLON Apr. 1986 56 p Partly in ENGLISH and DUTCH Sponsored by Rhone-Poulenc Sante
(VK-84-10; ISBN-90-6807-016-9; ETN-86-97768) Avail: Issuing Activity

It is shown that a patient possessing normal sensitivity to hypnotic drugs should be able to operate an automobile, in relative safety, 10 hr after ingesting nitrazepam 5 mg, flurazepam 2 mg, or zopiclone 7.5 mg. Residual driving performance impairment is expected during the morning following short-term, nocturnal use of flunitrazepam 2 mg, or zopiclone 7.5 mg, but not nitrazepam 5 mg. Residual impairment is expected in the afternoon following short-term, nocturnal use of flunitrazepam 2 mg, but not zopiclone 7.5 mg or nitrazepam 5 mg. Sleep quality is much improved by flunitrazepam 2 mg and zopiclone 7.5 mg, but less by nitrazepam 5 mg. Feelings of mental activation during the day following short term, nocturnal use of zopiclone 7.5 mg are initially (morning) less than normal, but eventually (afternoon) greater than normal. ESA

**N86-32955#** Department of the Air Force, Washington, D.C.
**VARIABLE CONTRAST DIRECT READ-OUT VISION TESTER Patent**
H. L. TASK and L. V. GENCO, inventors (to Air Force) 25 Feb. 1986 6 p
(AD-D012273; US-PATENT-4,572,630;
US-PATENT-APPL-SN-585092; US-PATENT-CLASS-351-243)
Avail: US Patent and Trademark Office CSCL 06L

A novel vision tester and vision testing method is described which comprises a pair of translucent displays, each transilluminated by electroluminescent lighting panels, the images of two patterns being superimposed to provide a combined image characterized by a pattern of variable contrast. Light sensors near

each light panel provide a measure of the relative intensities of the two images, which provides a measure of the contrast of each combined image. Contrast may be directly read out by processing the signals from the light sensors. The tester may be battery powered for portability. Author (GRA)

**N86-32956#** National Maritime Research Center, Kings Point, N. Y. Computer Aided Operations Research Facility.

**A SIMULATION STUDY OF THE EFFECTS OF SLEEP DEPRIVATION, TIME OF WATCH AND LENGTH OF TIME ON WATCH ON WATCHSTANDING EFFECTIVENESS**

A. D. DAMICO, E. KAUFMAN, and C. SAXE Jan. 1986 138 p (AD-A167729; CAORF-16-8122-02) Avail: NTIS HC A07/MF A01 CSCL 06S

Watchstander's work performance and physiological measures were studied in a simulated open-sea watch. A second purpose was to evaluate marine simulation as a method for studying the effects of such variables on mariner performance. Sleep deprivation is a common problem among mariners and was the primary variable of interest. Time of watch and length of time on watch were examined because of their interrelationship with the fatiguing effects of sleep deprivation. The standard work schedule of watch officers - four hours on and eight hours off work - is discordant with the typical work/rest schedules and accompanying circadian rhythm of most people. Thus, this watch schedule was expected to mediate the effects of sleep deprivation on watch standing. The length of time which a watch officer has stood a relatively uneventual watch was also expected to interact with the effects of sleep deprivation, such that the deleterous effects of sleep deprivation would be exacerbated as time on watch increased. Twenty-five watchstanding mates were assigned to one of four experimental groups: Group 1 slept for 7.5 hours, then stood a morning watch; Group 2 slept for 7.5 hours, then stood an afternoon watch; Group 3 received no sleep before standing a morning watch; Group 4 received no sleep before standing an afternoon watch. All watches were stood on the bridge of a full-scale full-mission shiphandling simulator. Dependent measures were collected before, during and after a four-hour watch. GRA

**N86-32957#** Hershey (Milton S.) Medical Center, Hershey, Pa.

**PREDICTORS OF PERIODIC BREATHING AT ALTITUDE**

D. P. WHITE, K. GLEESON, J. T. REEVES, C. K. PICKETT, A. M. RANNELS, A. CYMERMAN (Army Research Inst. of Environmental Medicine, Natick, Mass.), and J. V. WEIL Apr. 1986 31 p (AD-A167947; USARIEM-M27/86) Avail: NTIS HC A03/MF A01 CSCL 06P

Periodic breathing is commonly seen during sleep in healthy humans following ascent to high altitude. The hyperventilation induced by hypoxia at altitude leads to hypocapnia which can, during sleep, inhibit respiration yielding apnea. The subsequent fall in P02 and rise in PC02 could then trigger hyperventilation and perpetuate the cycle. This cycling requires sufficient hyperventilation in response to hypoxia and rising PC02 to produce the necessary level of hypocapnia. As a result, these events may be influenced by inter-individual variability in the hypoxic and hypercapnic ventilatory response. To test this theory, we measured hypoxic (HVR) and hypercapnic (HCVR) ventilatory responses awake and NREM sleep both at sea level and on nights 1, 4, and 7 following arrival at altitude (14,110 ft) in six healthy males. Ventilatory pattern and PC02 were also determined on these nights. On night 1 at altitude, periodic breathing developed in three of the six subjects and correlated significantly with the sea level NREM HVR ($r=.86$, $P=.02$), and near-significantly with both the sea level awake HVR ($r=.83$, $P=.08$), and sea level NREM HCVR ($r=.76$, $P=.08$). Periodic breathing decreased on nights 4 and 7, but an association persisted between the number of respiratory oscillations and the NREM hypercapnic response determined on the respective night (night 4, $r=.93$, $P=.02$; night 7, $r=.89$, $P=.04$). GRA

**N86-32958#** Federal Aviation Administration, Washington, D.C. Office of Aviation Medicine.

**INHALATION TOXICOLOGY. PART 6: EVALUATION OF THE RELATIVE TOXICITY OF THERMAL DECOMPOSITION PRODUCTS FROM 9 AIRCRAFT PANEL MATERIALS Final Report**

C. R. CRANE, D. C. SANDERS, B. R. ENDECOTT, and J. K. ABBOTT Feb. 1986 17 p (AD-A168250; FAA/AM-86/3-PT-6) Avail: NTIS HC A02/MF A01 CSCL 06T

The purpose of this study was to determine the relative toxicity of the combustion products from aircraft cabin panels, representing both composite and homogeneous construction, that were being tested concurrently for flammability and smoke production at the FAA Technical Center. A combustion/exposure assembly was designed and constructed in which panel sections were pyrolyzed by radiant head directed on the upper surface only; the relative toxicity of the evolved gases was measured by determining the effect (time-to-incapacitation) on the laboratory rat. Also determined was the realtive toxicity of gases from the same nine panels when pyrolyzed in the older (and smaller) combustion tube assembly in order to compare the effects of the different pyrolysis modes. GRA

**N86-32959#** Association of American Ultima Thule, Issaquah, Wash.

**EFFECTS OF HIGH ALTITUDE ON NEUROLOGICAL AND PULMONARY FUNCTION: THE EFFECT OF HIGH ALTITUDE ON VISUAL EVOKED POTENTIALS IN HUMANS ON MT. EVEREST Final Report, 15 Apr. 1984 - 14 Jul. 1985**

M. R. COLPITTS, R. N. WOHNS, Y. COLPITTS, T. CLEMENT, and W. B. BLACKETT 25 Jul. 1985 26 p (Contract DAMD17-84-G-4023; DA PROJ. 3E1-62777-A-879) (AD-A168335) Avail: NTIS HC A03/MF A01 CSCL 06S

The goal of the Ultima Thule Everest Expedition was to investigate the effects of high altitude on cerebral function. We were interested in noninvasive methods of assessing cerebral function at altitude and thus used electrophysiological tests involving cortical evoked potential studies and a drug study using Dilantin and placebo in a double blind randomized fashion. The subjects were climbers and support members of the expedition. Our hypothesis was that acute mountain sickness was a form of cerebral edema and could be objectively assessed with visual evoked potential measurements. Visual evoked potentials were chosen since it has been shown that these wave forms are directly altered by raised intracranial pressure. Dilantin was chosen as a drug that works in the CNS and stabilizes brain function. We hypothesized that Dilantin might prevent some of the symptoms of acute mountain sickness. Our studies revealed that exposure to high altitude, both with and without the symptoms of acute mountain sickness, altered the evoked potential patterns in a significant fashion. With comparison of baseline measurements to high altitude measurements it was seen that certain individuals had objective evidence of transient raised intracranial pressure. The Dilantin study was minimally conclusive based on lack of symptoms of altitude sickness, thus making comparison of the effects of Dilantin to placebo very difficult. However, it was seen that the subjects taking Dilantin had fewer and less headaches than the placebo group. GRA

**N86-32960#** Naval Aerospace Medical Research Lab., Pensacola, Fla.

**A COMPARISON OF THE SPECIFIC ABSORPTION RATE IN A HOMOGENEOUS MAN MODEL AND A MAN MODEL CONTAINING REALISTIC MODEL BONES**

T. A. GRINER and R. G. OLSEN 6 Jan. 1986 14 p (AD-A168547; NAMRL-1315) Avail: NTIS HC A02/MF A01 CSCL 06R

As part of a study of far-field microwave dosimetry in the human body, local and average specific absorption rates (SARs) in a homogeneous full-size muscle-equivalent upper-body man model were compared with measurements in an upper-body man model also containing simulated skull, brain material, oral and throat

cavities, and vertebrae. The measurements were made in the torso and head region at 2.0 GHz with e-polarized irradiation. Qualitative comparisons of front surface temperature were obtained with a thermographic camera. Whole-body SAR was measured with a gradient-layer calorimeter while SAR profiles at the eye and neck locations were measured using a nonperturbing temperature probe. The result of these comparisons showed minor differences in radio frequency (RF) absorption. At this frequency, the freespace wavelength (15 cm) is less than the major body dimensions, and the energy absorption ocurred primarily at the front surface of the model in a fairly uniform pattern. We conclude that the interior composition of our man model does not significant affect the over-all absorption characteristics at frequencies where the body dimensions are greater than the irradiation wavelength. GRA

**N86-32961#** Anco Engineers, Inc., Culver City, Calif.
**RADIOGRAPHIC DETERMINATION OF MASS OF INERTIAL TENSORS OF ANATOMICAL SEGMENTS Progress Report**
P. IBANEZ 3 Jan. 1986 13 p
(Contract N00014-85-C-0594)
(AD-A168581) Avail: NTIS HC A02/MF A01 CSCL 06E

ANCO is investigating the use of radiographic techniques to determine properties of anatomical segments - mass, center of gravity, and the inertial tensor. Three orthogonal projections (X-ray photographs) through the segment will determine these properties if sufficiently high energy X-rays are used so that attenuation is independent of atomic number and just dependent on mass density. This occurs above a few hundred keV energy. The intent of this study is to investigate the practicality and potential accuracy of the method. Progress to date is described herein. GRA

**N86-32962#** Army Research Inst. of Environmental Medicine, Natick, Mass.
**ALTITUDE ACCLIMATIZATION ATTENTUATES PLASMA AMMONIA DURING SUBMAXIMAL EXERCISE**
P. M. YOUNG, P. B. ROCK, C. S. FULCO, L. A. TRAD, and V. A. FORTE, JR. May 1986 27 p
(AD-A168630; USARIEM-M33/86) Avail: NTIS HC A03/MF A01 CSCL 07B

This study examined the effects of acclimatization to 4300 m altitude on changes in plasma ammonia concentrations with 30-min submaximal (75% VO2 max) cycle exercise. Human test subjects were divided into a sedentary (n=6) and active group (n=5). Maximal oxygen uptake (VO2 max) was determined at sea level, after acute HA (t24h) and chronic HA (t=13d), exposure to 4300 m altitude. The VO2 max of both groups decreased 32% with acute HA when compared to sea level. In the sedentary group, VO2 max was decreased an additional 16% following 13-days continuous residence at 4300 m, while VO2 max in the active group showed no further change. Plasma ammonia concentration increased (P0.05) over resting levels immediately following submaximal exercise during sea-level and acute HA exposure in both groups. Immediately following submaximal exercise at chronic HA, the active group showed no increased plasma ammonia accumulation, whereas the post-exercise ammonia in the sedentary group was elevated but to a lesser ex tent than sea level or acute HA. Thus, post-exercise plasma ammonia concentration is decreased with altitude acclimatization when compared to exercise performed at the same relative intensity at sea level or acute HA. This decrease in ammonia levels may contribute to enhanced performance and altered substrate utilization with exercise following acclimatization to altitude. GRA

**N86-32963#** Army Research Inst. of Environmental Medicine, Natick, Mass.
**EFFECT OF DEXAMETHASONE ON SYMPTOMS OF ACUTE MOUNTAIN SICKNESS AT PIKES PEAK, COLORADO (4300M)**
P. B. ROCK, T. S. JOHNSON, A. CYMERMAN, R. L. BURSE, and L. J. FALK May 1986 22 p
(AD-A168662; USARIEM-M-32/86) Avail: NTIS HC A02/MF A01 CSCL 06O

In a previous controlled study, dexamethasone (DEX) was shown to prevent acute mountain sickness (AMS) during exposure to simulated high altitude. To determine the effect of DEX during actual altitude exposure, sixteen young men were treated with either DEX (4 mg every 6h) or placebo for 48 h prior to and 48 h after being rapidly transported from sea level to the summit of Pikes Peak, CO (4300m). Symptoms of AMS were evaluated twice daily at Pikes Peak using the Environmental Symptoms Questionnaire and a clinical assessment. During treatment the mean symptom scores were higher for subjects taking placebo in 18 out of 20 comparisons. On an individual basis, 60% of the subjects receiving placebo met the criteria of being sick compared to 31% of subjects receiving DEX. Beginning 24 h after cessation of treatment, DEx subjects experienced a progressive increase in symptom scores which lasted through the end of the altitude sojourn (day 6). The results indicate that DEX is an effective prophylactic treatment for AMS in an actual mountain environment, but the AMS symptoms can occur if the drug is stopped abruptly. drug is stopped abruptly. GRA

**N86-32964#** Brookhaven National Lab., Upton, N. Y.
**PROPOSAL FOR A NEW TOMOGRAPHIC DEVICE PROVIDING INFORMATION ON THE CHEMICAL PROPERTIES OF A BODY SECTION**
E. GATTI, P. REHAK, and J. KEMMER (Technische Univ., Munich (West Germany).) 27 Feb. 1986 68 p Presented at the 4th European Symposium on Semiconductor Detectors, Munich, West Germany, 3 Mar. 1986 Prepared in cooperation with Beschleunigerlaboratorium der Univ. und Technischen Univ. Muenchen, Garching (Germany, F.R.).
(Contract DE-AC02-76CH-00016)
(DE86-010547; BNL-37795; CONF-8603109-3) Avail: NTIS HC A04/MF A01

A system to analyze the chemical properties of a region of tissue located deep inside the human body without having to access it is proposed. The method is based on a high precision detection of X-rays or (GAMMA)-rays (photons) from an external source Compton scattered from the tissue under inspection. The method provides chemical information of plane regions lying not too deep inside the body (<6 cm). The amount of radiation absorbed by the body is about the same as needed for a standard X-ray tomography. The exposure time is estimated to be shorter than 10 minutes. DOE

**N86-32965#** Technische Hogeschool, Eindhoven (Netherlands). Vakgroep Meten en Regelen.
**IMPLEMENTATION OF MODELS FOR THE TRANSIENT DIVISION SYSTEM OF SPATIO-TEMPORAL VISUAL PERCEPTION [IMPLEMENTATIE VAN MODELLEN VOOR HET TRANSIENTE DEELSYSTEEM VAN DE SPATIO-TEMPORELE VISUELE WAARNEMING]**
A. C. DENBRINKER May 1984 124 p In DUTCH
(ETN-86-97533) Avail: NTIS HC A06/MF A01

Three adaptive filter based models for the mathematical description of a spatial two-dimensional choroid membrane placed inside the transient system of visual perception were derived. Via estimate procedures applied to psychophysical impulse responses (IR) the model parameters for different subjects were determined. One model in which the temporary system as estimated from measurement results was placed in series with the membrane leads to the conclusion that membrane currency effects are no longer essential. A model in which the lateral membrane was identified with a second filter from the adaptive filter model, predicts an IR with more than 3 phases, for simulation with a 1 deg field without environment. Later phases are big enough to be measured by the model. A third model in which part of the estimated IR is identified with the membrane action was tested. ESA

**N86-32966#** Technische Hogeschool, Eindhoven (Netherlands). Vakgroep Meten en Regelen.
**A MODEL OF THE TRANSIENT PART OF THE SPATIO-TEMPORAL PERCEPTION, CONTAINING A TWO-DIMENSIONAL LONG FIBER [EEN MODEL VAN HET TRANSIENTE DEEL VAN DE SPATIO-TEMPORELE VISUELE PERCEPTIE, BEVATTENDE EEN TWEE-DIMENSIONALE LANGE LEIDING]**
A. C. DENBRINKER and T. J. P. VANAALST May 1984 34 p In DUTCH
(ETN-86-97540) Avail: NTIS HC A03/MF A01

A Griffith visual perception model containing a lateral (choroid) membrane for extension and coupling of signals in the spatial domain was developed. The membrane was mathematically described using the long fiber analogy of nerve fibers. Propagation velocity (v) and damping (beta) were included. The parameters were assumed to be independent of the average luminance via adaptive processes to calculate luminous pattern discontinuities into discontinuities of beta and v. A linear Partial Differential Equation (PDE) was found; the appropriate Green function was derived. Starting from a membrane excitation by a disk direct-impulse superposed on a continously present luminance profile, PDE solutions were obtained for profiles from which the luminance is equally distributed, and constantly distributed inside the disk and zero outside, or tending to infinity outside. ESA

# 53

# BEHAVIORAL SCIENCES

Includes psychological factors; individual and group behavior; crew training and evaluation; and psychiatric research.

**A86-47498#**
**A MODEL OF THE HUMAN'S USE OF VISUAL FIELD CUES IN NAP-OF-THE-EARTH FLIGHT**
R. A. HESS (California, University, Davis) and K. K. CHAN IN: Guidance, Navigation and Control Conference, Williamsburg, VA, August 18-20, 1986, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1986, p. 875-885. refs (AIAA PAPER 86-2252)

A model for the human pilot's use of visual field cues for vehicular control in nap-of-the-earth flight is quantified and combined with a structural model of the human pilot. As such, the model represents a description of preview control for this flight task. Manned simulation and flight test experiments for low altitude lateral-directional maneuvering provide corroborative data for the modeling approach. The model is seen to represent a qualitative as well as quantitative method for analyzing relevant perceptual factors in low altitude vehicular control. Author

**A86-49371**
**THE EFFECT OF CENTEDRIN ON THE WORK CAPACITY OF OPERATORS [VLIIANIE TSENTEDRINA NA RABOTOSPOSOBNOST' SPETSIALISTOV OPERATORSKOGO PROFILIA]**
V. D. BAKHAREV, I. B. SLIUSAR, and IU. U. MANKOV Voenno-Meditsinskii Zhurnal (ISSN 0026-9050), March 1986, p. 44, 45. In Russian.

The effect of centedrin on the productivity of operators engaged in collective activity (in groups of three) with either psychologically compatible or incompatible partners was investigated, using a training simulator for imitation of search and sensorimotor operations. Ninety-three experimental subjects, who received 0.01 g of centedrin 2.5 h before the test, were divided into three categories: (1) 10 groups (of 3 subjects each) in which the subjects were psychologically compatible, (2) 10 groups made up of psychologicaly incompatible partners, and (3) 11 groups in which the subjects were indifferent towards each other. A control group of 30 did not receive the drug. When working on individual assignments, all subjects receiving centedrin exhibited higher indices of productivity than the controls. However, in tests requiring collective efforts, the subjects of the psychologically incompatible category exhibited abnormal irritability and poor coordination in collective efforts, resulting in the lowest productivity among the studied groups. The collective productivity results among the groups of the psychologically compatible category were the highest. I.S.

**A86-49521*** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
**DEVELOPMENT OF INTUITIVE THEORIES OF MOTION - CURVILINEAR MOTION IN THE ABSENCE OF EXTERNAL FORCES**
M. K. KAISER (NASA, Ames Research Center, Moffett Field, CA; Michigan, University, Ann Arbor), M. MCCLOSKEY (Johns Hopkins University, Baltimore, MD), and D. R. PROFFITT (Virginia, University, Charlottesville) Developmental Psychology (ISSN 0012-1649), vol. 22, no. 1, 1986, p. 67-71. refs
(Contract NIH-HD-16195)

College students and children between the ages of 4 and 12 were asked to draw the path a ball would take upon exiting a curved tube. As in previous studies, many subjects erroneously predicted curvilinear paths. However, a clear U-shaped curve was evident in the data: Preschoolers and kindergartners performed as well as college students, whereas school-aged children were more likely to make erroneous predictions. A second study suggested that the youngest children's correct responses could not be attributed to response biases or drawing abilities. This developmental trend is interpreted to mean that the school-aged children are developing intuitive theories of motion that include erroneous principles. The results are related to the 'growth errors' found in other cognitive domains and to the historical development of formal theories of motion. Author

**A86-49633*#** Georgia Inst. of Tech., Atlanta.
**AIDING THE OPERATOR DURING NOVEL FAULT DIAGNOSIS**
W. C. YOON and J. M. HAMMER (Georgia Institute of Technology, Atlanta) IEEE, International Conference on Systems, Man, and Cybernetics, Tucson, AZ, Nov. 12-15, 1985, Paper. 10 p. refs
(Contract NAG2-123)

An aid is proposed for the operator who must deal with a novel failure. A novel failure is one that is not covered by the operator's training or procedures or by an expert system (if present). The aid contains a disaggregated model of the system for reasoning causally about the system. It is to work in parallel with the human and interact at various levels of control. It is designed specifically to mitigate some human suboptimalities and biases during decision making. Author

**A86-49870*** California State Univ., Hayward.
**ON MARCHING TO TWO DIFFERENT DRUMMERS - PERCEPTUAL ASPECTS OF THE DIFFICULTIES**
S. T. KLAPP, M. D. HILL, J. G. TYLER, Z. E. MARTIN (California State University, Hayward), R. J. JAGACINSKI (Ohio State University, Columbus) et al. Journal of Experimental Psychology: Human Perception and Performance (ISSN 0096-1523), vol. 11, 1985, p. 814-827. refs
(Contract NCC2-223; NAG2-195; NSF BNS-82-04811)

Three experiments which reveal that the difficulties involved in processing conflicting rhythms occur when monitoring a stimuli and indicating termination of one rhythmic sequence or tapping with one hand are described. The relation between perceiving and acting in temporal tapping tasks is studied. The effects of varying temporal compatibility on perceptual monitoring and one-hand tapping are examined. It is observed that the difficulty of two-handed tapping to polyrhythms with two different tones decreases as pitch differences between tones decrease, and the difficulty of rhythmic coordination can be perceptually controlled. It is noted that the evaluation of polyrhythmic performance provides a useful means of examining the interactions of perceptual and motor organizations. I.F.

**A86-50283*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.
**FLIGHT TRAINING FOR SPACE SHUTTLE MISSIONS**
F. E. HUGHES (NASA, Johnson Space Center, Houston, TX) Society for Computer Simulation, Multiconference, San Diego, CA, Jan. 23, 24, 1986, Paper. 7 p.

The training performed for flights of the Space Shuttle is intensive and extremely complicated. The training is totally dependent on computer generated training situations in both cockpit simulations and in integrated simulations between the simulators and the Mission Control Center (MCC). These simulations form a complex set of dress rehearsals of the actual spaceflight allowing the participants to address problems in a real world situation and utilize problem solving rationale just as they will be called upon to do during the real flight. The benefits of this type of training have been demonstrated during the flights of the Shuttle as individual flight controllers and whole teams have been tested by various untoward situations. This system of integrated simulation and training, more complex than ever, will be continued in use in the future using even more intricate man-machine interactions required to initialize, control, and operate it. Author

**N86-32095#** Shape Technical Center, The Hague (Netherlands). Operations Research Div.
**USE OF ARTIFICIAL INTELLIGENCE AND PSYCHOLOGY IN THE ANALYSIS OF COMMAND AND CONTROL**
J. T. DOCKERY and J. VANDENDRIESSCHE Feb. 1985 272 p
(Contract STC-80-5/I)
(STC-TM-749; ETN-86-97393) Avail: NTIS HC A12/MF A01

The psychological profile and behavior of a military decision maker under stress were studied. Use of a systems simulation language to study reactions in air defense situations was assessed.
ESA

**N86-32096#** Shape Technical Center, The Hague (Netherlands). Operations Research Div.
**THE PSYCHOLOGY OF DECISION MAKING**
*In its* Use of Artificial Intelligence and Psychology in the Analysis of Command and Control p 1-61 Feb. 1985
Avail: NTIS HC A12/MF A01

A psychological profile of a military commander under stress is outlined. Information processing states for a decision-maker under stress are introduced. Bias and processing of information are discussed. Descriptive decision-making rather than normative decision making is used to describe the commander. ESA

**N86-32097#** Shape Technical Center, The Hague (Netherlands). Operations Research Div.
**ARTIFICIAL INTELLIGENCE AND THE RULE ORIENTED SYSTEM SIMULATION (ROSS) LANGUAGE**
*In its* Use of Artificial Intelligence and Psychology in the Analysis of Command and Control p 62-262 Feb. 1985
Avail: NTIS HC A12/MF A01

The use of the Rule Oriented System Simulation language (which unites concepts of artificial intelligence and event step simulation in an object oriented simulation language) in an air defense simulation; a purely psychological experiment on the computer; and a simulation of engagement decision logic in an air defense battalion operations center with a fuzzy set logic program is described. Ideas on joining artificial intelligence and catastrophe theory are discussed. The latter is used as a source of decision rules. The classical ambush situation is analyzed.
ESA

**N86-32098#** Rochester Inst. of Tech., N. Y. Dept. of Electrical Engineering.
**SPEECH ANALYSIS BASED ON A MODEL OF THE AUDITORY SYSTEM Final Report, Oct. 1983 - Sep. 1985**
H. E. RHODY, R. A. HOUDE, C. W. PARKINS, and S. DIANAT Feb. 1986 54 p
(Contract F30602-81-C-0169)
(AD-A167426; RADC-TR-85-265) Avail: NTIS HC A04/MF A01 CSCL 20A

This report describes a signal processing technique for speech signals based on a model of the processing done in the auditory system. It has been found that the click response of the auditory system is an exponential function. The spectrogram produced by a speech waveform that has been windowed by the same function possesses excellent resolution of both time and frequency parameters of the signal. It is expected that this analysis method will improve the discrimination of phonemic elements, and will prove useful in such applications as speech recognition and speech compression. GRA

**N86-32099#** European Space Agency, Paris (France).
**SPEED OF WORK AND ERROR RATE: ANALYSES OF INDIVIDUAL DIFFERENCES IN A CHOICE REACTION SERIES WITH A COGNITIVE COMPONENT**
K. M. GOETERS Dec. 1985 23 p Original language document was announced as N86-10781
(ESA-TT-944; DFVLR-FB-85-21; ETN-86-97579) Avail: NTIS HC A02/MF A01; original German version available from DFVLR, Cologne, West Germany DM 10.50

A visual choice reaction test with a cognitive component was introduced to measure response processes in more detail than is possible with summarizing scoring of paper pencil tests. For each reaction the following information was registered: stimulus (light) reaction (right/wrong), reaction time, and omission (yes/no). Each subject had to react on 320 successive signals without pause. From the reaction protocol of each subject indices for speed of work, oscillation of performance, error disposition, and reaction inhibition were computed. The main results is that in this reaction test speed of work and error disposition are not coupled. Errors are not a consequence of quick reactions. The observed errors seem to be the expression of an increased variation in performance. The results are discussed with a view to a psychophysiological model of activation. ESA

**N86-32100#** Institute for Perception RVO-TNO, Soesterberg (Netherlands). Experimental Psychology Group.
**AUDITORY VERSUS VISUAL SELECTIVE-ATTENTION TASKS**
L. C. BOER and M. H. B. RUZIUS Oct. 1985 27 p
(Contract A83/K/045)
(IZF-1985-19; TDCK-93575; ETN-86-98043) Avail: NTIS HC A03/MF A01

The Dichotic Listening Task (DLT) of Gopher and Kahnemann (1971), which requires subjects to detect targets occurring in one of two messages while ignoring the other, was compared with the Rapid Serial Visual Presentation (RSVP) based on a paradigm of Sperling and Reeves (1980). Subjects were required to detect targets occurring in one of two letter streams while ignoring the other. The performance on DLT and RSVP correlate, but not beyond the basic level between any pair of information processing tasks. Suggestions for RSVP modifications emphasizing selective-attention requirements are considered. ESA

**N86-32967#** Anacapa Sciences, Inc., Fort Rucker, Ala.
**HUMAN FACTORS RESEARCH IN AIRCREW PERFORMANCE AND TRAINING Annual Summary Report, Sep. 1981 - Aug. 1982**
K. D. CROSS Dec. 1985 77 p
(Contract MDA903-81-C-0504; DA PROJ. 2Q2-63743-A-792; DA PROJ. 2Q2-63743-A-793)
(AD-A167740; ASI-479-19-2; ARI-RN-85-103) Avail: NTIS HC A05/MF A01 CSCL 05I

This report presents Human Factors Research in Aircrew Performance and Training, for the Army Research Institute Field

Unit at Fort Rucker, Ala. The report contains summary descriptions for each of the eleven projects on which contractor personnel worked during the first contract year. Each summary description contains: (1) a background section that describes the rationale for the research need and the project objectives, (2) a research project that describes the tasks and activities required to fulfill the project objectives, and (3) a project status section that describes the work completed, preliminary findings (if available) and the anticipated project completion date. GRA

**N86-32968#** Massachusetts Inst. of Tech., Cambridge. Artificial Intelligence Lab.
**PERSPECTIVE PROJECTION INVARIANTS**
A. VERRI and A. YUILLE Feb. 1986 17 p
(Contract N00014-80-C-0505)
(AD-A167783; AI-M-832) Avail: NTIS HC A02/MF A01 CSCL 12A

An important part of stereo vision consists of finding and matching points in two images which correspond to the same physical element in the scene. This document shows that zeros of curvature of curves are perspective invariants and can therefore be used to find corresponding points. These can be used to help solve the registration problem and to obtain the correct depth when a curve enters the forbidden zone. These are also relevant to theories for representing image curves. The stability of these zeros of curvature are considered. Author (GRA)

**N86-32969#** Hershey (Milton S.) Medical Center, Hershey, Pa.
**DATA COLLECTION VIA A QUASI-EXPERIMENTAL SIMULATION TECHNOLOGY. PART 1: MULTIPLE MEASUREMENT OF PERFORMANCE EXCELLENCE IN COMPLEX AND UNCERTAIN MANAGERIAL TASKS Interim Report**
S. STREUFERT, R. M. POGASH, and M. T. PIASECKI Apr. 1986 74 p
(Contract MDA903-83-C-0106; DA PROJ. 2Q1-61102-B-74-F)
(AD-A167949; ARI-RN-86-41) Avail: NTIS HC A04/MF A01 CSCL 05A

A simulation technique is used to determine whether complexity (multidimensionality) of task performance in complex managerial tasks is trainable. The present report is specifically concerned with measurement. Previous simulation based measurement, which had included sixteen measures was extended to thirty-seven primary measures and twelve derived measures. Information is provided on the characteristics and purpose of each of those measures. In addition formulas or related statements that allow calculation of performance scores by other researchers and/or in other settings is provided. Further, this report considers the Time-Event Matrix on which measurement is based. GRA

**N86-32970#** School of Aerospace Medicine, Brooks AFB, Tex.
**THE STARTLE REFLEX AS A LEARNING TASK: APPARATUS AND TEST PARAMETERS Interim Technical Paper Jun. - Sep. 1985**
D. G. EVANS, L. B. ANDERSON, S. Z. BROTHERS, S. L. HUTCHINSON, and T. G. WHEELER Mar. 1986 12 p
(AD-A167958; USAFSAM-TP-85-6) Avail: NTIS HC A02/MF A01 CSCL 06P

The objective of this report is to define the startle reflex inhibition learning task and to present results of a pilot study designed to determine the experimental conditions which produce the most consistent learning curves. The startle response (muscle flinch) to each tone stimulus was recorded via an accelerator voltage output. The three primary task parameters--tone intensity, interstimulus interval (ISI), and adaptation period-were evaluated to determine which parameters were important in producing consistent learning curves. The results indicate that ISI and adaptation period have little effect on the inhibition learning curves and tone intensity proved to be the primary variable for the range of conditions used in this study. GRA

**N86-32971#** Federal Aviation Administration, Washington, D.C. Office of Aviation Medicine.
**COMPLEX MONITORING PERFORMANCE AND THE CORONARY-PRONE TYPE A BEHAVIOR PATTERN Final Report**
R. I. THACKRAY and R. M. TOUCHSTONE Mar. 1986 15 p
(AD-A168240; AD-E900565; FAA/AM-86/4) Avail: NTIS HC A02/MF A01 CSCL 05J

The present study examined the possible relationship of the coronary-prone Type A behavior pattern to performance of a complex monitoring task. The task was designed to functionally simulate the general task characteristics of future, highly automated air traffic control systems in which passive monitoring is expected to be a principal job requirement. Thirty-six male subjects, half classified as Type A and half as Type B, monitored the simulated radar display over a 2-hour session for infrequent critical changes in alphanumeric targets. In addition to performance, physiological changes and subjective reactions were also assessed. Type A individuals were found not to differ from Type B individuals in either task performance or in subjective reaction to the task. Task-related changes in heart rate, blood pressure, and general restlessness failed also to provide any evidence of greater arousal in Type A's than in Type B's. The findings are discussed relative to other studies of Type A behavior and performance and to the specific problem of finding useful predictors of performance in operational monitoring situations. GRA

**N86-32972#** Naval Aerospace Medical Research Lab., Pensacola, Fla.
**MULTITASK PERFORMANCE: PREDICTING SUCCESS IN NAVAL AVIATION PRIMARY FLIGHT TRAINING Interim Report**
G. R. GRIFFIN and D. K. MCBRIDE Mar. 1986 20 p
(AD-A168246; NAMRL-1316) Avail: NTIS HC A02/MF A01 CSCL 05I

A multitask experiment simulating certain motor control and communication requirements characteristics of flight was conducted to determine relative strengths of several performance measures as predictors of primary flight training success. A Psychomotor Task (PMT) and a Dichotic Listening Task (DLT) performed under single-task conditions were found to be significantly related (p less .05) to a primary flight training pass/fail criterion. Two separate multitask DLT measures also correlated with the pass/fail criterion and at higher levels of statistical significance (p less than .01) than the single-task measures. The results indicate that various single- and multitask measures are significantly related to primary flight performance, and further reveal that the component test measures may be better predictors under multitask than under single-task conditions. Additional research using larger samples and additional multitask tests is indicated. GRA

**N86-32973#** Perceptronics, Inc., Woodland Hills, Calif.
**OPERATOR ALERTNESS/WORKLOAD ASSESSMENT USING STOCHASTIC MODEL-BASED ANALYSIS OF MYOELECTRIC SIGNALS Final Report, Apr. 1984 - Oct. 1985**
A. MADNI, C. CONAWAY, S. OTSUBU, and Y. Y. CHU Nov. 1985 130 p
(Contract F49620-83-C-0001)
(AD-A168567; PFTR-1126-85-11; AFOSR-86-0325TR) Avail: NTIS HC A07/MF A01 CSCL 05I

This report summarizes the research conducted in the second phase of this three-year research and development program directed toward the analysis and evaluation of myoelectric signals (MES) as indicators of operator alertness and piloting workload. The purpose of the study was to investigate the efficiency of stochastic models such as autoregressive (AR), autoregressive-moving-average (ARMA), and autoregressive integrated moving average (ARIMA) models in characterizing the MES under different levels of task-imposed burden. The implications from this three-year research program are two-fold. Surface myoelectric activity is not a reliable measure of operator alertness. During Phase 1, the first autoregressive coefficient of the ARIMA model revealed a significant correlation with task

difficulty level. During Phase 3, the pi weights did not show the same trend. Intramuscular electrodes, on the other hand, that do pick up more reliable signatures have obvious drawbacks. Post hoc analysis of the experimental data revealed that the total number of experimental subjects which were constrained by program scope and size were inadequate in terms of producing a statistically significant difference in perceived stress between the single and dual-task groups. GRA

**N86-32974#** Perceptronics, Inc., Woodland Hills, Calif.
**OPERATOR ALERTNESS/WORKLOAD ASSESSMENT USING STOCHASTIC MODEL-BASED ANALYSIS OF MYOELECTRIC SIGNALS Interim Report, Apr. 1983 - Oct. 1985**
A. MADNI, C. CONAWAY, S. OTSUBU, Y. Y. CHU, and D. PURCELL Nov. 1985 83 p
(Contract F49620-83-C-0001)
(AD-A168568; PIR-1126-85-4; AFOSR-86-0317TR) Avail: NTIS HC A05/MF A01 CSCL 05I

This report summarizes the activities in the second phase of a three-year program of research and development directed toward the analysis and evaluation of myoelectric signals (MES) as indicators of operator alertness, and potentially workload in aircraft piloting tasks. The purpose of the study is to investigate the efficiency of stochastic models such as autoregressive (AR), autoregressive-moving-average (ARMA) and autoregressive integrated moving average (ARIMA) models in characterizing the MES under different levels of task imposed burden. The specific objectives of this effort are: (1) to develop/adapt state-of-the-art stochastic models for characterizing myoelectric signal patterns; (2) To investigate under controlled experimental conditions if meaningful repeatable quantitative relationships can be identified between MES patterns and operator loading; (3) To experimentally identify muscle sites that provide reliable MES signatures; (4) To develop methods and procedures for tuning the models and possibly filtering out pattern variations due to variables in electrode locations and individual biases; and (5) To develop guidelines for automatically assessing operator alertness level from the MES temporal signature in piloting tasks. Author (GRA)

**N86-32975#** Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Abteilung Flaechenflugzeuge.
**INVESTIGATION OF PILOT BEHAVIOR WITHIN THE SCOPE OF A TRAINING PROGRAM FOR HANDLING QUALITIES RATING IN A GROUND SIMULATOR**
D. ALTENKIRCH May 1985 41 p In GERMAN; ENGLISH summary
(DFVLR-MITT-86-01; ISSN-0176-7739; ETN-86-97814) Avail: NTIS HC A03/MF A01; DFVLR, Cologne, West Germany DM 15.50

A pilot training session for rating handling qualities of transport aircraft was conducted with four test pilots by using a moving cockpit ground simulator. Each pilot flew three tasks: take-off/climb, cruise/landing, approach/touchdown. In addition to the basic version of the aircraft, the pilots rated the handling qualities of two configurations differing in dynamics and control modes. Cooper-Harper pilot ratings and special effort ratings, as well as statistical values computed from measured performance data of the pilot/aircraft system are presented as a function of the configuration and turbulence levels. ESA

# 54

# MAN/SYSTEM TECHNOLOGY AND LIFE SUPPORT

Includes human engineering; biotechnology; and space suits and protective clothing.

**A86-47440*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
**DESIGN FOR A GOAL-ORIENTED TELEROBOTIC SYSTEM**
R. W. WILL and N. O. SLIWA (NASA, Langley Research Center, Hampton, VA) IN: Guidance, Navigation and Control Conference, Williamsburg, VA, August 18-20, 1986, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1986, p. 357-363. refs
(AIAA PAPER 86-2090)

Robotic systems will play an increasingly important role in space operations. This paper describes the objective and design of a proposed goal-oriented telerobotic system for space operations. This design effort encompasses the elements of the system executive and user interface, and the distribution and general structure of the knowledge bases, the displays, and the task sequencing. The objective of the design effort is to provide an evolutionary structure for a telerobotic system, i.e., one that can progress from strictly teleoperated through phases of serving as an assistant, a colleague, and an expert, to eventually serve as a truly autonomous unit, requiring only minimal supervision. A preliminary design for such a system involving 'mixed initiative', or the flexible shared control between the human operator and the software system, is complete and described in this paper. Author

**A86-47467#**
**ON-ORBIT MANIPULATORS - SENSORY AND CONTROL APPROACHES**
J. MCLAUGHLIN, B. STAUNTON, and L. WARD (Aerospace Corp., El Segundo, CA) IN: Guidance, Navigation and Control Conference, Williamsburg, VA, August 18-20, 1986, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1986, p. 591-598. Research supported by the Aerospace Corp. refs
(AIAA PAPER 86-2185)

This paper presents an overview of ongoing research, describing work on some control issues relevant to space applications of robotics and teleoperation. Problems in manipulator path tracking, absolute position control, and link flexibility are addressed. A hardware experiment demonstrates the application of modern control design to trajectory control of a manipulator with nonlinear dynamics. Work on camera modeling and the use of computer vision and estimation in closed-loop position control is detailed. A two link, flexible manipulator is modeled and a linearization approach to controlling end-effector oscillations is simulated. Author

**A86-47726**
**SAFE ASSOCIATION, ANNUAL SYMPOSIUM, 23RD, LAS VEGAS, NV, DECEMBER 1-5, 1985, PROCEEDINGS**
Van Nuys, CA, SAFE Association, 1986, 336 p. For individual items see A86-47727 to A86-47765.

The conference presents papers on flow stagnation as an advanced windblast protection technique, the evaluation of a preejection upper torso retraction device, the risk of collision in a two-seat aircraft ejection, the design of a portable/collapsible hyperbaric chamber, the development of a controllable catapult for ejection seats, an engineering test and evaluation of several new anti-G valves, and the advanced chemical-defense aircrew respirator. Consideration is also given to a molecular sieve oxygen generation system onboard the B-1B bomber, high speed ejection tests of a modified hybrid III manikin, the development of a portable oxygen system analyzer,

Mach-number-immune-microprocessor-controlled sequencer for open ejection seats using onboard environmental sensors, and advancements in inertia reels for fixed seating aircraft. Papers are also presented on systems safety analysis methods applied to computer software, the changing face of constant wear anti-exposure protection, a new standard for protective headgear, the development of a mechanical analog of a human spine and viscera, the evolution of the seawater activated release stem system, concept development of a canopy escape module, improvements/modifications to new naval helicopter helmets, and the relationship of intravascular bubbles to bends at altitude.
K.K.

**A86-47732**
**DESIGN OF A PORTABLE, COLLAPSIBLE HYPERBARIC CHAMBER**
R. ALGERA (ILC Industries, Inc., ILC Dover, Frederica, DE) and G. A. DIXON (USAF, School of Aerospace Medicine, Brooks AFB, TX) IN: SAFE Association, Annual Symposium, 23rd, Las Vegas, NV, December 1-5, 1985, Proceedings . Van Nuys, CA, SAFE Association, 1986, p. 59-63.

As extravehicular activity (EVA) becomes more commonplace in space the potential for the occurrence of decompression sickness (DCS) also increases. Once DCS symptoms occur, it is necessary to initiate compression therapy as quickly as possible. Due to weight and space limitations of the Shuttle Spacecraft, the use of a conventional hyperbaric chamber is not feasible, and a lightweight, portable, collapsible fabric hyperbaric enclosure is required for Space Shuttle missions. The design definition, materials selection, and operational procedures for two portable hyperbaric chambers operating at 26.5 psid and 73.5 psid, respectively are discussed along with future plans for fabrication and testing of the 26.5 psid portable hyperbaric chamber. Author

**A86-47734**
**AN ENGINEERING TEST AND EVALUATION OF SEVERAL NEW ANTI-G VALVES**
L. J. MEEKER (USAF, School of Aerospace Medicine, Brooks AFB, TX), A. G. KRUEGER (Technology, Inc., San Antonio, TX), and P.E. LOVE IN: SAFE Association, Annual Symposium, 23rd, Las Vegas, NV, December 1-5, 1985, Proceedings . Van Nuys, CA, SAFE Association, 1986, p. 69-72.

Because of the many problems encountered in the high +G(Z) environment of modern high performance fighter aircraft, there has been a recent increased interest in the development of an improved anti-G valve (AGV). Six types of AGVs were tested, with five of these being new or experimental valves and the sixth being the standard Alar included for comparison purposes. All tests were accomplished unmanned on the USAFSAM Centrifuge. Specifically designed flexible (low stretch) bladders were fabricated to simulate three G suit volumes. AGV pressures were measured both at the outlet of the valve and from a catheter installed in the bladder. Pressure versus G(Z) deviation was measured against a 1.5 psig/G(Z) standard, for high G(Z) onset runs. Author

**A86-47735**
**'THE ACDAR' - ADVANCED CHEMICAL DEFENSE AIRCREW RESPIRATOR**
W. K. ANSITE (Scott Aviation, Lancaster, NY) IN: SAFE Association, Annual Symposium, 23rd, Las Vegas, NV, December 1-5, 1985, Proceedings . Van Nuys, CA, SAFE Association, 1986, p. 73-75.

**A86-47737**
**MOLECULAR SIEVE OXYGEN GENERATION SYSTEM (MSOGS) ONBOARD THE B-1B BOMBER**
J. B. TEDOR (USAF, School of Aerospace Medicine, Brooks AFB, TX) IN: SAFE Association, Annual Symposium, 23rd, Las Vegas, NV, December 1-5, 1985, Proceedings . Van Nuys, CA, SAFE Association, 1986, p. 81-84. refs

The B-1B MSOGS is the first onboard breathing gas generation system installed on operational USAF aircraft. MSOGS uses pressure swing adsorption to separate oxygen from nitrogen in the engine bleed air stream. The nitrogen-rich fraction vents overboard, while the oxygen-enriched breathing gas flows to the aircrew. This unlimited oxygen supply replaces comonly carried liquid oxygen stores, which may restrict mission durations or basing opportunities. The system provides physiologically adequate oxygen concentration and breathing gas flow for the crew under all anticipated flight conditions. MSOGS is designed for high reliability, low maintenance, safety, and cost effectiveness, while enhancing mission capabilities. Author

**A86-47739**
**THE DEVELOPMENT OF TWO PROTOTYPE FACIAL PROTECTION SYSTEMS FOR HIGH PERFORMANCE AIRCREW HELMETS**
J. B. PEDDER, N. SHEWCHENKO, J. A. NEWMAN (Biokinetics and Associates, Ltd., Ottawa, Canada), and J. W. ARMSTRONG (Department of National Defence, Defence and Civil Institute of Environmental Medicine, Downsview, Canada) IN: SAFE Association, Annual Symposium, 23rd, Las Vegas, NV, December 1-5, 1985, Proceedings . Van Nuys, CA, SAFE Association, 1986, p. 102-107. refs

**A86-47740**
**NEW DEVELOPMENTS IN ON BOARD OXYGEN GENERATORS**
B. M. BREWER, R. J. SEARLE, and G. F. STEVENSON (Normalair Garrett, Ltd., Life Support Div., Yeovil, England) IN: SAFE Association, Annual Symposium, 23rd, Las Vegas, NV, December 1-5, 1985, Proceedings . Van Nuys, CA, SAFE Association, 1986, p. 116-121.

The design and packaging of the present range of On Board Oxygen Concentrators has been largely dictated by the need to install the units in the space envelope already available in an existing aircraft design. Normally this has been the space formally occupied by the liquid oxygen (LOX) converter. It is anticipated that the next generation of aircraft will be designed, ab initio, to utilize on board generation of breathing gas. The space and shape constraints of present systems are not ideal for the design of the concentrator and their revision may also be of benefit to the airframe design. To take advantage of the 'clean sheet' approach offered by new aircraft, a study has been made of improved designs leading to low volume and weight with minimized demand on aircraft bleed air and electrical services. One result of this study is a novel, compact concentrator which is now under development. This paper discusses progress, to date, with this project and points the way to future developments. Author

**A86-47742**
**DEVELOPMENT OF A PORTABLE OXYGEN SYSTEM ANALYZER**
R. D. HOLDEN, J. B. TEDOR, A. O. BERGQUIST, D. S. MORAN, and M. J. EISERER (USAF, School of Aerospace Medicine, Brooks AFB, TX) IN: SAFE Association, Annual Symposium, 23rd, Las Vegas, NV, December 1-5, 1985, Proceedings . Van Nuys, CA, SAFE Association, 1986, p. 126-129.

Test and man-rating of the B-1B Molecular Sieve Oxygen Generating System (MSOGS) required analytical methods for evaluating system performance both in the laboratory and on the aircraft. In conjunction with the performance testing and man-rating of the MSOGS in USAFSAM laboratories a portable oxygen system analyzer was developed. The Oxygen System Analyzer is capable of monitoring aircaft cabin pressure and three MSOGS performance variables: (1) system gas flow rate, (2) product oxygen concentration, (3) system outlet pressure. The analyzer is a portable tester designed to be used in a frequent basis to ascertain breathing system performance and assure reliability and safety. The device may be used either to perform pre- and postflight system checks, or to assess inflight performance characteristics and compliance with design specifications. The analyzer is packaged in a flightworthy case (20 x 13 x 8.5 inches, 31 pounds) and operates from a 12 volt rechargeable power system for 8-10 hours. Presently all data must be hand logged from three 3 1/2 digit calibrated light emitting diode (LED) type digital panel meters, but a magnetic

tape recording system could be added if necessary. The analyzer is readily capable of being adapted to assess performance of other types of breathing systems, whether onboard aircraft, other vehicles, or at fixed locations. Author

**A86-47746**
**TACTICAL LIFE SUPPORT SYSTEM (TLSS) AIRCREW INTEGRATED GARMENT**
R. D. MICHAS, J. C. STEFFLER, F. BUICK, and K. N. ACKLES (Department of National Defence, Defence and Civil Institute of Environmental Medicine, Downsview, Canada) IN: SAFE Association, Annual Symposium, 23rd, Las Vegas, NV, December 1-5, 1985, Proceedings . Van Nuys, CA, SAFE Association, 1986, p. 158-161.

Past efforts to protect aircrew have generally concentrated on the development of life support equipment for a single application. As a result, individual items lack mutual compatibility and, in combination, performance is often unacceptable. The Tactical Life Support System (TLSS) recently developed under U.S. Air Force contract for aircrew of advanced tactical aircraft addresses this problem. It includes an integrated personal garment for acceleration, altitude, thermal and chemical protection, incorporating positive pressure breathing capability and personal cooling by means of a liquid transport undergarment. A modular aproach was used for optimum cost, logistics and maintenance. Analysis of integration options, design of components and interfaces between components and with aircraft systems are discussed. Flight test of the TLSS by the USAF is scheduled for end 1986. Author

**A86-47747**
**CURRENT RESEARCH ON ADVANCED CONCEPT ANTI-G SUITS**
R. E. VAN PATTEN (USAF, Aerospace Medical Research Laboratory, Wright-Patterson AFB, OH) IN: SAFE Association, Annual Symposium, 23rd, Las Vegas, NV, December 1-5, 1985, Proceedings . Van Nuys, CA, SAFE Association, 1986, p. 162-164. refs

Recent research at the Armstrong Aerospace Medical Research Laboratory has demonstrated a fundamental shortcoming of conventional anti-G suits with respect to their inability to maintain venous return during sustained acceleration. A sequentially inflating, pulsatile, microprocessor-controlled anti-G suit was developed in order to attack this problem. This paper discusses the underlying physiological shortcomings of conventional anti-G suits and presents detailed information on the design and implementation of the advanced concept anti-G suit. Author

**A86-47749**
**THE CHANGING FACE OF CONSTANT WEAR ANTI-EXPOSURE PROTECTION**
S. M. REEPS, L. W. WORMSER, R. T. ERICKSON, and G. R. WHITMAN (U.S. Navy, Naval Air Development Center, Warminster, PA) IN: SAFE Association, Annual Symposium, 23rd, Las Vegas, NV, December 1-5, 1985, Proceedings . Van Nuys, CA, SAFE Association, 1986, p. 171-177. refs

The provision of constant wear anti-exposure protection has always meant a compromise between the level of protection provided and in-flight comfort and performance. An overview of programs currently being pursued by the Naval Air Development Center, aimed at optimizing the anti-exposure compromise, are discussed. These programs are improving the compromise by bringing state-of-the-art materials and technology to the Fleet. Items currently being introduced, or soon to be introduced, include the CWU-62/P PTFE Coverall, the CWU-72/P Anti-Exposure Liner, improved coverall components and sizing, and lighter weight hoods and mittens. Details of recent cold water testing of the CWU-62/P and CWU-72/P, under conditions of induced leakage, are discussed as well as a review of the effects of these garments on mobility and heat stress during flight. Author

**A86-47751**
**TEST AND EVALUATION OF THE B-1B MOLECULAR SIEVE OXYGEN GENERATING SYSTEM**
J. P. CLINK and J. B. TEDOR (USAF, School of Aerospace Medicine, Brooks AFB, TX) IN: SAFE Association, Annual Symposium, 23rd, Las Vegas, NV, December 1-5, 1985, Proceedings . Van Nuys, CA, SAFE Association, 1986, p. 185-189.

The U.S. Air Force School of Aerospace Medicine tested a molecular sieve oxygen generating system developed for the B-1B bomber to determine performance characteristics and man-rate the sytem prior to flight test. A series of unmanned and manned tests covering the range of aircraft operating conditions were conducted on a duplicate of the aircraft breathing system assembled in an environmental chamber. Cabin and aircraft ambient pressure, inlet air temperature and pressure, cabin temperature, and demand flow were the control variables; oxygen concentration and pressure at the outlet of the breathing regulator were the dependent variables. Oxygen output exceeded specification requirements for all but two test points. Under nominal aircraft operating conditions and a maximum demand flow of 160 liters per minute (1 pm), oxygen concentration fell slightly below specification requirements at 25,000 and 28,000 ft cabin altitude. Breathing characteristics of the system met specification requirements, but also exhibited a slight, sporadic pressure oscillation in the regulated breathing gas. The purging system, designed to minimize the delay in receiving back-up oxygen at the breathing mask during raid decompression, functioned properly but did not deliver 100 percent oxygen within the specified time limit. Nevertheless, the system is satisfactory for flight use. The small oxygen concentration variances will have no significant impact on crew safety or performance; the regulator oscillation has been corrected with a minor design change; and an easily implemented improvement of the purge system is being evaluated. Author

**A86-47752**
**A NEW STANDARD FOR PROTECTIVE HEADGEAR - BS 6658**
D. H. GLAISTER (USAF, School of Aerospace Medicine, Brooks AFB, TX) IN: SAFE Association, Annual Symposium, 23rd, Las Vegas, NV, December 1-5, 1985, Proceedings . Van Nuys, CA, SAFE Association, 1986, p. 190-193. refs

The protective capability of military headgear is based upon specifications, test methods, and pass/fail criteria, defined in appropriate national standards. Thus, flight helmets currently worn by RAF aircrew depend upon the British Standards Institution's specifications for protective headgear for vehicle users. The advent of a new standard, BS 6658, which will replace standards BS 5361 and 2495, will therefore impinge upon the performance expected from future RAF aircrew headgear. The paper concentrates on one of the newly defined test procedures, an oblique impact test, and explains its rationale and development. This test evaluates the protection offered by a helmet against an off-axis or glancing blow in which the brain injury mechanism is the level of induced angular acceleration. Briefly, the helmet is mounted on a headform which is complete with chin and neck and is dropped in guided free-fall onto an inclined anvil with a vertical velocity, at impact, of 10/ms. The induced forces are recorded from the instrumented anvil, and pass/fail criteria are based upon the peak recorded tangential force (related to peak angular acceleration) and its integral with time (related to induced angular velocity). These criteria are discussed in relation to human head tolerance levels. Author

**A86-47761**
**IMPROVEMENTS AND MODIFICATIONS TO NAVAL HELICOPTER HELMETS**
R. P. HAY, D. M. NICOLO, and C. GDOWIK (U.S. Navy, Naval Air Development Center, Warminster, PA) IN: SAFE Association, Annual Symposium, 23rd, Las Vegas, NV, December 1-5, 1985, Proceedings . Van Nuys, CA, SAFE Association, 1986, p. 265-267.

**A86-47762**
**SINGLE STAGE RAPID RESPONSE ANTI-G VALVE**
W. LAM and M. RATAJCZAK (Moog, Inc., East Aurora, NY) IN: SAFE Association, Annual Symposium, 23rd, Las Vegas, NV, December 1-5, 1985, Proceedings . Van Nuys, CA, SAFE Association, 1986, p. 268-272.

Modern high performance fighter aircraft such as the F-16 and F-18 are capable of producing both high g forces and rapid onset rates of these g forces. Presently the limiting element to the high g flight profile is the physiological capability of the pilot. In order to exploit the full capabilities of today's aircraft, the g force tolerance of the pilot must be enhanced. One possible way to increase the pilot's tolerance is to use a high response g suit system which closely follows the g force being experienced. This paper discusses the development of a rapid response, single stage servo controlled anti-g valve. Design features are discussed, as well as tests that have been conducted on a system which simulates a suit installation on an F-16. Test results are presented which demonstrate that the anti-g valve meets the requirements defined in NADC Specification N62269-82-R0420. The valve provides a 'normal' and a 'combat' mode of operation. In the Combat mode, compensation is provided to allow for the delay associated with suit time constant. It is demonstrated that flow restrictions in the line between the valve and the g suit have an effect on the overall system performance. It is submitted that this warrants further investigation. Author

**A86-47764**
**ANTI-G SUIT PROTECTION AND BODY POSITION**
E. HENDLER (Human Factors Applications, Inc., Warminster, PA), L. HREBIN, and P. WHITLER (U.S. Navy, Naval Air Development Center, Warminster, PA) IN: SAFE Association, Annual Symposium, 23rd, Las Vegas, NV, December 1-5, 1985, Proceedings . Van Nuys, CA, SAFE Association, 1986, p. 299-302.

It is hypothesized that if the pilots of high-performance fighter and attack aircraft are supinated, they can better tolerate the high G loads these aircraft are capable of generating. Results are presented of a study undertaken to ascertain the effects upon relaxed G tolerance of some G protective techniques including the use of the anti-G suit (AGS) and supination. When the pressure applied to AGS bladders was reduced in accordance with the calculated reduction in hydrostatic blood column height (brought about by supinating relaxed subjects), G protection provided by the AGS was greater than that provided when the relaxed subjects were seated upright. K.K.

**A86-47766**
**EVALUATION OF MAN-MACHINE SYSTEMS: METHODS AND PROBLEMS; SYMPOSIUM, NOVEMBER 14, 15, 1985, COLOGNE, WEST GERMANY, REPORTS [BEWERTUNG VON MENSCH-MASCHINE-SYSTEMEN: METHODEN UND PROBLEMATIK; SYMPOSIUM, NOVEMBER 14, 15, 1985, COLOGNE, WEST GERMANY, VORTRAEGE]**
Symposium sponsored by DGLR. Bonn, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1985, 276 p. In German and English. For individual items see A86-47767 to A86-47775.
(DGLR-BERICHT 85-04)

Various papers on the evaluation of man-machine systems are presented. The topics discussed include: anthropometric conditions for the construction of a helicopter cockpit, obstacle warning radar for helicopters, determination of the load and stress on cockpit crew during flight using tasking networks and the SAINT simulation language, and application of the method of problem taxonomy to the simulation of human service reliability in the manual steering of aircraft. Also considered are: investigating the ocular fixation of targets as an anthropotechnical research method in man-machine systems, a basic concept for evaluating man-machine systems, techniques of asking questions in the evaluation of man-machine systems. C.D.

**A86-47767#**
**EVALUATION OF MAN-MACHINE SYSTEMS - INTRODUCTION AND OVERVIEW [BEWERTUNG VON MENSCH-MASCHINE-SYSTEMEN - EINFUEHRUNG UND UEBERSICHT]**
K.-P. GAERTNER and W. STEIN (Forschungsinstitut fuer Anthropotechnik, Wachtberg-Werthhoven, West Germany) IN: Evaluation of man-machine systems: Methods and problems; Symposium, November 14, 15, 1985, Cologne, West Germany, Reports . Bonn, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1985, p. 2-9. In German.

The organization, evaluation, and study of man-machine systems are discussed. Decisions to be made during each of these tasks are specified. Empirical and model-based methods of studying man-machine systems are briefly addressed. Problems to be overcome in reconciling the various goals involved in optimizing man-machine systems are considered. C.D.

**A86-47770#**
**DETERMINATION OF THE LOAD AND STRESS ON A COCKPIT CREW DURING FLIGHT USING TASKING NETWORKS AND THE SAINT SIMULATION LANGUAGE [ERMITTLUNG DER BELASTUNG BZW. -BEANSPRUCHUNG EINER COCKPITBESATZUNG BEI DER FLUGZEUGFUEHRUNG MIT HILFE VON AUFGABENNETZWERKEN UND DER SIMULATIONSSPRACHE SAINT]**
M. FRICKE, U. KOPP, and D. NIEMEYER (Berlin, Technische Universitaet, West Germany) IN: Evaluation of man-machine systems: Methods and problems; Symposium, November 14, 15, 1985, Cologne, West Germany, Reports . Bonn, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1985, p. 34-45. In German. refs

The load/stress on a cockpit crew of a B 727 during an ILS CAT I flight was investigated by digital simulation of more than 20 flights. A model describing the complex working process of the flight crew and its interaction with the environment is developed. The simulation flights are described, and the various tasks engaged in by the crew during the flights are specified and discussed. C.D.

**A86-47771**
**APPLICATION OF THE METHOD OF PROBLEM TAXONOMY TO THE SIMULATION OF HUMAN SERVICE RELIABILITY IN THE MANUAL STEERING OF AIRCRAFT [ANWENDUNG DER METHODE DER AUFGABENTAXONOMIE ZUR SIMULATION DER MENSCHLICHEN BEDIENZUVERLAESSIGKEIT BEI DER MANUELLEN STEUERUNG VON FLUGZEUGEN]**
K. BRAUSER (Messerschmitt-Boelkow-Blohm GmbH, Munich, West Germany) IN: Evaluation of man-machine systems: Methods and problems; Symposium, November 14, 15, 1985, Cologne, West Germany, Reports . Bonn, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1985, p. 46-61. In German. refs
(MBB-LKE-301/S/PUB/216)

The method of problem taxonomy, based on data on human reliability and aimed at obtaining improved surveying and evaluation of such data, is described. The simulation of the problem of manual steering of an aircraft pitching axis during landing approach using this method together with the simulation program SAINT is discussed. The human error probability for various steering errors obtained using the method is reported. C.D.

**A86-47772#**
**INVESTIGATING THE OCULAR FIXATION OF TARGETS AS AN ANTHROPOTECHNICAL RESEARCH METHOD IN MAN-MACHINE SYSTEMS [DIE BLICKZIELUNTERSUCHUNG ALS ANTHROPOTECHNISCHE UNTERSUCHUNGSMETHODE IM MENSCH-MASCHINE-SYSTEM]**
R. UCKERMANN (DFVLR, Institut fuer Flugfuehrung, Brunswick, West Germany) IN: Evaluation of man-machine systems: Methods and problems; Symposium, November 14, 15, 1985, Cologne, West Germany, Reports . Bonn, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1985, p. 187-199. In German. refs

Methods and instrumentation used in research on the sequence of eye fixations performed by an aircraft pilot as he guides an aircraft are discussed. The oculogram method, the cornea-reflex method, and the motionless method used in the DEBIC apparatus are summarized, and the apparatus used by the DFVLR are described. Research results obtained using these methods and apparatus are briefly discussed. C.D.

**A86-47773#**
**A BASIC CONCEPT FOR EVALUATING MAN-MACHINE SYSTEMS [GRUNDKONZEPT FUER BEWERTUNG VON MENSCH-MASCHINE-SYSTEMEN]**
J.-H. KIRCHNER (Braunschweig, Technische Universitaet, Brunswick, West Germany) IN: Evaluation of man-machine systems: Methods and problems; Symposium, November 14, 15, 1985, Cologne, West Germany, Reports . Bonn, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1985, p. 200-212. In German.

The requirements for evaluating man-machine systems are given, and evaluation procedures are discussed in detail. Direct and indirect evaluation of man-machine systems is addressed. A concept for such evaluation is developed, stressing its ergonomic aspects. C.D.

**A86-47774#**
**TECHNIQUES OF ASKING QUESTIONS IN THE EVALUATION OF MAN-MACHINE SYSTEMS [BEFRAGUNGSTECHNIKEN BEI DER BEWERTUNG VON MENSCH-MASCHINE-SYSTEMEN]**
M. SCHUETTE (Dortmund, Universitaet, West Germany) and W. LAURIG IN: Evaluation of man-machine systems: Methods and problems; Symposium, November 14, 15, 1985, Cologne, West Germany, Reports . Bonn, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1985, p. 213-228. In German. refs

The study of loads imposed on a person and the resulting psychophysical consequences for that person in the context of a man-machine interaction is discussed. Both environmentally caused and task-based loads are considered. Two approaches to investigating these aspects of man-machine systems are examined, an older one-dimensional approach and a more recent multidimensional one. The resulting evaluation of loads in either absolute or relative terms is discussed. C.D.

**A86-47775#**
**A MEASURE OF USABILITY**
W. FLOHRER (Standard Elektrik Lorenz AG, Stuttgart, West Germany) IN: Evaluation of man-machine systems: Methods and problems; Symposium, November 14, 15, 1985, Cologne, West Germany, Reports . Bonn, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1985, p. 229-238.

In order to evaluate the usability of technical equipment not only the time of operation and the error rate have to be considered but also the learning process, i.e., the function time of operation versus number of repeated test trials. The analysis of data (test results), collected over many years, has shown, that the learning curve can be approximated by a simple mathematical formula; the parameters of which differ from one system, device or equipment to another but can easily be calculated. The parameters found can be used to evaluate technical equipment with respect to its usability. Such a measure of usability could enable the engineer or manager to compare technical equipment not only by technical viewpoints or costs but also by one criterion of human factors engineering. Author

**A86-48309#**
**USER INTERFACE DESCRIPTION OF A GAS TURBINE CONTROL SYSTEM**
M. SREETHARAN and J. FISTERE (Solar Turbines Inc., San Diego, CA) ASME, International Gas Turbine Conference and Exhibit, 31st, Duesseldorf, West Germany, June 8-12, 1986. 9 p. refs (ASME PAPER 86-GT-296)

Human factors must be given primary consideration in the design of today's control systems. It is essential to take into account the characteristics of the human operator, the plant control requirements and the inherent characteristics of the control system. This paper discusses the objectives of the control interface development task for a turbomachinery micro-processor based control system. It discusses the design issues raised during development, the choices made in the early structuring of the system and selected implementation details that affect the operator interface. Subjects discussed include: (1) overall philosophy and console arrangements, (2) pushbutton vs keyboard functions, (3) video display philosophy and organization, (4) ladder-diagram graphic symbols, (5) keyboard command philosophy and structure, and (6) diagnostic features and maintainability. Author

**A86-48553#**
**DEVELOPMENT OF A HIERARCHICAL MULTIPROCESSOR CONTROL FOR A POLYARTICULATED MECHANICAL STRUCTURE USED TO STUDY HUMAN OPERATORS SUBJECTED TO VIBRATIONS [REALISATION D'UNE COMMANDE HIERARCHISEE MULTIPROCESSEUR D'UNE STRUCTURE MECANIQUE POLYARTICULEE UTILISEE POUR L'ETUDE DE L'OPERATEUR HUMAIN SOUMIS A DES VIBRATIONS]**
H. EZZEDINE Valenciennes et Hainaut-Cambresis, Universite, Docteur Ingenieur Thesis, 1985, 143 p. In French. refs

A mobile visual information support has been developed to test different laws of the head displacement of a pilot on a vibration generator relative to the information he observes, in order to determine their influence on the visual and manual performance of a human operator. A review of the effects of vibration on vision, and of the characteristics of the vibration generator, establish specifications for the visual information support. Based on these specifications, and the constraints imposed by the applied acceleration and speed, a model of the entire system's mechanical structure is presented. A three-level hierarchical multiprocessor control is then described, consisting of an upper level for the real-time command of experimental protocol, an intermediary level to coordinate the movements, and a level of local loading securing the follow-up of commands. Finally, experimental results of the performance of the control and safety systems are presented. R.R.

**A86-48713*** Kansas State Univ., Manhattan.
**IMPROVED FLEXIBILITY OF AN EVA GLOVE**
G. W. EGGEMAN and J. J. HELD (Kansas State University of Agriculture and Applied Science, Manhattan) IN: 1986 SEM Spring Conference on Experimental Mechanics, New Orleans, LA, June 8-13, 1986, Proceedings . Bethel, CT, Society for Experimental Mechanics, Inc., 1986, p. 788-792. NASA-supported research.

A student design contest was held between four universities. The project was to improve the flexibility of the NASA extra-vehicular activities (EVA) glove with the internal pressure increased from 4 psi to 8 psi. The Kansas State University team used an experimental design methodology and an industrial management scheme. This approach succeeded in making Kansas State University the winner of the competition. Author

**A86-49552*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
**AUTOMATION AND ROBOTICS FOR SPACE STATION IN THE TWENTY-FIRST CENTURY**
K. F. WILLSHIRE (NASA, Langley Research Center, Hampton, VA) and D. L. PIVIROTTO (California Institute of Technology, Jet Propulsion Laboratory, Pasadena) AIAA, Space Station in the Twenty-first Century, Meeting, Reno, NV, Sept. 3-5, 1986. 7 p. refs
(AIAA PAPER 86-2300)

Space Station telerobotics will evolve beyond the initial capability into a smarter and more capable system as we enter the twenty-first century. Current technology programs including several proposed ground and flight experiments to enable development of this system are described. Advancements in the areas of machine vision, smart sensors, advanced control architecture, manipulator joint design, end effector design, and artificial intelligence will provide increasingly more autonomous telerobotic systems. Author

**A86-49634*#** Georgia Inst. of Tech., Atlanta.
**ISSUES IN RULE IDENTIFICATION AND LOGICAL INDUCTION**
C. M. LEWIS (Georgia Institute of Technology, Atlanta) IEEE, International Conference on Systems, Man, and Cybernetics, Tucson, AZ, Nov. 12-15, 1985, Paper. 10 p. refs
(Contract NAG2-123)

The relationship between language and empirical fitting of data is discussed. The production system is presented as an appropriate description of human behavior in Man-Machine systems. Issues arising in the identification of rules from data are examined. Rules identified through logical generalization are shown to be equivocal. Difficulties arising from the use of logic-based procedures with human performance data containing errors are explored. Problems relating to rule sets which are not disjoint are discussed and a solution presented. Significant testing issues are raised for rule identification and a procedure based on controlling contrivedness is presented. A synthesis of data and knowledge-based approaches is suggested as a remedy to many of the difficulties discussed. Author

**N86-32101*#** Wisconsin Univ., Madison. Dept. of Horticulture.
**CONTROLLED ENVIRONMENT LIFE SUPPORT SYSTEM: GROWTH STUDIES WITH POTATOES**
T. W. TIBBITTS and R. M. WHEELER Mar. 1986 52 p
(Contract NCC2-301)
(NASA-CR-177400; NAS 1.26:177400) Avail: NTIS HC A04/MF A01 CSCL 05H

Results of experiments conducted to maximize the productivity of potatoes grown under controlled environmental conditions are discussed. A variety of parameters is examined which affect potato growth, specifically, photoperiod, light intensity, temperature, nitrogen nutrition, carbon dioxide concentration and culture techniques. These experiments were conducted using five different cultivars, Russet Burbank, Norchip, Superior, Kennebec and Norland. To achieve high productivity, three specific objectives were explored: (1) to develop effective cultural procedures, (2) to determine the most effective photoperiod and (3) to develop a mist culture system. It is felt that the productivity obtained in this study is below the maximum that can be obtained. High irradiance levels coupled with tuber-promoting conditions such as cooler temperatures, increased CO2 levels and lowered nitrogen concentrations should allow increases in tuber production. Tuberization appears to be accelerated by short daylengths although final yields are not increased. Mist culture techniques have not yet produced fully developed tubers. The use of supporting media and alteration of the nitrogen content of the mist solution are being explored as a way to allow tubers to develop to maturity. Author

**N86-32102*#** National Aeronautics and Space Administration, Washington, D.C.
**NASA FACTS: SPACE SHUTTLE FOOD SYSTEMS**
1986 15 p
(NF-150/1-86) Avail: Issuing Activity CSCL 06H

On the Space Shuttle, the food is prepared at a galley installed on the Orbiter's mid-deck. The galley is a modular unit that can be removed for special weight-critical missions or missions that require extra interior space. It contains a personal hygiene station, a water dispenser, an oven, condiment and meal tray stowage, and a food preparation area. Foods are individually packaged and stowed for easy handling in the zero gravity of space. All food is precooked or processed so it requires no refrigeration and is either ready to eat or can be prepared simply by adding water or heating. The only exception is the fresh fruit and vegetables stowed in the fresh food locker. The supplies consist of rehydratable food and beverages, thermostabilized food, intermediate moisture foods, natural form foods, irradiated meats, and condiments. A sample menu is also included. B.G.

**N86-32103#** Air Force Inst. of Tech., Wright-Patterson AFB, Ohio.
**ABSOLUTE JUDGMENT VERSUS ABSOLUTE MAGNITUDE ESTIMATION TO CONVEY INFORMATION THROUGH SYMBOL MAGNITUDE CHANGES IN CRT DISPLAYS M.S. Thesis**
B. ASIU Dec. 1985 75 p
(AD-A167059; AFIT/CI/NR-86-38T) Avail: NTIS HC A04/MF A01 CSCL 09D

Psychophysical scaling of symbol magnitude to convey information through CRT displays was evaluated in terms of information theory. Series of lines and ellipses each with four, eight and twelve intermediate sizes were presented to twelve subjects under absolute judgment scaling and to an additional twelve subjects under absolute magnitude estimation scaling. Under absolute judgment, information transmission is higher and equivocation and ambiguity measures are lower than those obtained under absolute magnitude estimation. The difference in information transmission represents an increase of about one stimulus alternative under absolute judgement scaling and in itself does not preclude the practical application of absolute magnitude estimation to encode information. Rather it is the wide variability in median magnitude estimations that makes it difficult to reach any common ground for symbol interpretation. Author (GRA)

**N86-32104#** Georgia Inst. of Tech., Atlanta. Center for Man-Machine Systems Research.
**HUMAN PROBLEM SOLVING IN FAULT DIAGNOSIS TASKS Final Report, Jul. 1979 - Jul. 1982**
W. B. ROUSE and R. M. HUNT Apr. 1986 55 p
(Contract MDA903-79-C-0421; DA PROJ. 2Q1-61102-B-74-F)
(AD-A167397; ARI-RN-86-33) Avail: NTIS HC A04/MF A01 CSCL 05J

This report evaluates the nature of human problem solving abilities specifically related to fault diagnosis situations. Three types of fault diagnosis were analysed involving diagnosis utilizing both real equipment and computer simulated equipment failures. In addition, the investigators experimented with computer generated problem solving aids to supplement human decision making capacities in diagnostic tasks. Results of the initial investigation indicate that human problem solving tends to be highly context-specific but that pattern recognition capabilities are exceptional allowing for a high degree of accuracy in ambiguous problem solving situations. Both structured-oriented and strategy-oriented problem solving aids were analysed. Structured-oriented bookkeeping aids clearly improved performance, while strategy-oriented aids actually had a negative effect on transfer of training. This research effort is clearly relevant to military interests in effective training of optimal decision making in sub-optimal conditions. The results strongly support further research into the nature and training of effective solving. GRA

**N86-32105#** Lawrence Livermore National Lab., Calif.
**STRIVING FOR NATURAL USAGE**
N. A. STORCH 1986 9 p Presented at the ACM/SIGCHI '86: Human Factors in Computing Systems, Boston, Mass., 16 Apr. 1986
(Contract W-7405-ENG-48)
(DE86-009402; UCRL-94415; CONF-8604159-1) Avail: NTIS HC A02/MF A01

During the past year, the Non-Destructive Evaluation Section has supported developing a user environment for their technicians and scientists who do image processing and analysis of images obtained from various sources. In particular, this has involved bringing together certain software tools which already existed into a prototype, trying to understand user needs by observation, discussion, insightful guessing, and then continuing on to build something better. One of the primary goals has been to achieve a natural user interface. The efforts have required internal complexity in handling: pointing of the user to the image or screen and resultant actions, device independent graphics and raster operations, application menus, working image data base and command recognition. These are, for the most part, independent of the image processing functions. Starting from broad, not very well defined requirements, it has become an on-going effort to checkout both interactive and image processing operations. A framework was developed to allow for flexibility in image processing operations and their integration into work-related applications. The results indicate that success in accomplishing an easy, natural usage is due to: commitment and concentration on usage, continual reevaluation during development, and allowance for the overhead of tidying up to maintain internal order and clarity. DOE

**N86-32106#** National Aerospace Lab., Amsterdam (Netherlands). Flight Div.
**CONTROL THEORETIC ANALYSIS OF HUMAN OPERATOR MEDIATED RENDEZVOUS AND DOCKING**
P. MILGRAM and P. H. WEWERINKE 26 Feb. 1985 10 p Presented at 2nd IFAC/IFIP/IFORS/IEA Conf. on Analysis, Design and Evaluation of Man-Machine Systems, Varese, Italy, 10-12 Sep. 1985
(NLR-MP-85020-U; B8661085; ETN-86-97669) Avail: NTIS HC A02/MF A01

A model based analysis of manual control of space rendezvous and docking in the presence of transmission time delays (nominal case: human operator (HO) on the ground) is presented. The variables studied are time delay, human induced motor noise levels, rotational and translational control and the effect of display prediction. An envelope of performance is estimated, bounded by performance with optimal prediction and performance with no prediction at all. Nominal performance for a simple second order Taylor predictor display is estimated. An HO imperfect internal representation of the system is used to model the no-predictor and predictor display cases. ESA

**N86-32107#** National Aerospace Lab., Amsterdam (Netherlands). Space Flight Div.
**CONTROL LOOPS WITH HUMAN OPERATORS IN SPACE OPERATIONS. PART 1: HUMAN ENGINEERING ANALYSIS, SYNTHESIS AND EVALUATION TECHNIQUES Final Report**
P. MILGRAM, R. C. VANDEGRAAFF, and P. H. WEWERINKE Paris ESA 17 May 1985 280 p
(Contract ESA-5594/83)
(NLR-TR-84116-L-PT-1; ESA-CR(P)-2190-PT-1; ETN-86-97787)
Avail: NTIS HC A13/MF A01

Human engineering approaches and methodologies applicable for analysis of performance of human-machine systems, particularly space teleoperator applications, are reviewed. Motivated by the presumed active role of the human operator in future space teleoperation missions, the application of human engineering within the various stages of system development is discussed, emphasizing the impact on the development cycle of being able to analyze various aspects of human-in-the-loop system performance. Experimental and theoretical approaches to human performance analysis are identified. Fundamental and practical aspects of each approach are outlined. A modeling approach for the analysis of a specific class of supervisory space teleoperator missions is proposed. Human-computer task allocation for such missions is considered. ESA

**N86-32108#** National Aerospace Lab., Amsterdam (Netherlands). Space Flight Div.
**CONTROL LOOPS WITH HUMAN OPERATORS IN SPACE OPERATIONS. PART 3: RENDEZVOUS AND DOCKING OPERATIONS AND MODEL ANALYSIS OF PERFORMANCE WITH HUMAN-IN-THE-LOOP Final Report**
P. MILGRAM, P. T. L. M. VANWOERKOM, and P. H. WEWERINKE Paris ESA 7 Dec. 1984 192 p
(Contract ESA-5594/83)
(NLR-TR-84116-L-PT-3; ESA-CR(P)-2190-PT-3; ETN-86-97789)
Avail: NTIS HC A09/MF A01

Human-in-the-loop rendezvous and docking (RVD) performance was analyzed to demonstrate the practicality of applying engineering methods and techniques to the analysis of control loops with human operators in space operations. The RVD space segment and the related autonomous operations are described. Model analyses of RVD performance in the final approach phase, for the case in which the human operator is involved in manual control of RVD, and for the case in which the human operator is monitoring an automated RVD for the occurrence of failures are given. ESA

**N86-32109#** National Aerospace Lab., Amsterdam (Netherlands). Space Flight Div.
**CONTROL LOOPS WITH HUMAN OPERATORS IN SPACE OPERATIONS. PART 4: RESEARCH REQUIREMENTS FOR HUMAN-IN-THE-LOOP SPACE TELEOPERATOR DEVELOPMENT Final Report**
P. MILGRAM Paris ESA 17 May 1985 62 p
(Contract ESA-5594/83)
(NLR-TR-84116-L-PT-4; ESA-CR(P)-2190-PT-4; ETN-86-97790)
Avail: NTIS HC A04/MF A01

Short-term human engineering research requirements for developing rendezvous and docking and space telemanipulation capabilities are presented. A catalog of research topics related to human-in-the-loop teleoperation performance is given. Available resources for model analytical investigation of these research topics and resources for the establishment of an initial human performance research laboratory for carrying out such investigations and for testing proposed design concepts by ESA are reviewed. ESA

**N86-32110#** National Aerospace Lab., Amsterdam (Netherlands). Space Flight Div.
**CONTROL LOOPS WITH HUMAN OPERATORS IN SPACE OPERATIONS. PART 5: EXECUTIVE SUMMARY Final Report**
P. MILGRAM Paris ESA 17 May 1985 157 p
(Contract ESA-5594/83)
(NLR-TR-84116-L-PT-5; ESA-CR(P)-2190-PT-5; ETN-86-97791)
Avail: NTIS HC A08/MF A01

Human engineering analysis, synthesis, and evaluation techniques; robotics operations and manual control experiments; spacecraft rendezvous and docking operations and model analysis of performance with human-in-the-loop; and ESA research requirements for human-in-the-loop space teleoperator development are discussed. ESA

**N86-32976*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**TWENTY-FIRST ANNUAL CONFERENCE ON MANUAL CONTROL**

R. A. MILLER, comp. (Ohio State Univ., Columbus.) and R. J. JAGACINSKI, comp. May 1986 504 p Conference held in Columbus, Ohio, 17-19 Jun. 1985

(Contract NAG2-195)

(NASA-CP-2428; A-86218; NAS 1.55:2428) Avail: NTIS HC A22/MF A01 CSCL 05H

The proceedings of the entitled conference are presented. Twenty-nine manuscripts and eight abstracts pertaining to workload, attention and errors, controller evaluation, movement skills, coordination and decision making, display evaluation and human operator modeling and manual control.

**N86-32977*#** Bolt, Beranek, and Newman, Inc., Cambridge, Mass.

**DESCRIPTIVE LINEAR MODELING OF STEADY-STATE VISUAL EVOKED RESPONSE**

W. H. LEVISON, A. M. JUNKER (Aerospace Medical Research Labs., Wright-Patterson AFB, Ohio.), and K. KENNER (Synergy, Inc., Washington, D. C.) *In* NASA. Ames Research Center 21st Annual Conference on Manual Control 16 p May 1986

Avail: NTIS HC A22/MF A01 CSCL 05H

A study is being conducted to explore use of the steady state visual-evoke electrocortical response as an indicator of cognitive task loading. Application of linear descriptive modeling to steady state Visual Evoked Response (VER) data is summarized. Two aspects of linear modeling are reviewed: (1) unwrapping the phase-shift portion of the frequency response, and (2) parsimonious characterization of task-loading effects in terms of changes in model parameters. Model-based phase unwrapping appears to be most reliable in applications, such as manual control, where theoretical models are available. Linear descriptive modeling of the VER has not yet been shown to provide consistent and readily interpretable results. Author

**N86-32978*#** Aerospace Medical Research Labs., Wright-Patterson AFB, Ohio.

**ANALYTICAL COMPARISON OF TRANSIENT AND STEADY STATE VISUAL EVOKED CORTICAL POTENTIALS**

A. M. JUNKER, K. M. KENNER, D. L. KLEINMAN, and T. D. MCCLURG *In* NASA. Ames Research Center, 21st Annual Conference on Manual Control 14 p May 1986

(Contract AF-AFOSR-2312-V2)

Avail: NTIS HC A22/MF A01 CSCL 05H

To better describe the linear-dynamic properties of the human visual-cortical response system, transient and steady state Visual Evoked Response Potentials (VERP) were observed. The stimulus presentation device provided both the evoking stimulus (flickering or pulsing lights) and a video task display. The steady state stimulus was modulated by a complex, ten frequency, sum-of-sines, wave. The transient VERP was the time-locked average of the EEG to a series of narrow light pulses (pulse width of 10 msec). The Fourier transform of the averaged pulses had properties that approximate band limited white noise, i.e., a flat spectrum over the frequency region spanned by the 10 summed sines. The Fourier transform of both the steady state and the transient evoked potentials resulted in transfer that are equivalent and therefore comparable. To investigate the effects of task loading on evoked potentials, a grammatical reasoning task was provided. Results support the relevancy of continued application of a systems engineering approach for describing neurosensory functioning. Author

**N86-32979*#** California Univ., Los Angeles.

**MODIFIED PETRI NET MODEL SENSITIVITY TO WORKLOAD MANIPULATIONS**

S. A. WHITE, D. P. MACKINNON, and J. LYMAN *In* NASA. Ames Research Center, 21st Annual Conference on Manual Control 17 p May 1986

Avail: NTIS HC A22/MF A01 CSCL 05H

Modified Petri Nets (MPNs) are investigated as a workload modeling tool. The results of an exploratory study of the sensitivity of MPNs to work load manipulations in a dual task are described. Petri nets have been used to represent systems with asynchronous, concurrent and parallel activities (Peterson, 1981). These characteristics led some researchers to suggest the use of Petri nets in workload modeling where concurrent and parallel activities are common. Petri nets are represented by places and transitions. In the workload application, places represent operator activities and transitions represent events. MPNs have been used to formally represent task events and activities of a human operator in a man-machine system. Some descriptive applications demonstrate the usefulness of MPNs in the formal representation of systems. It is the general hypothesis herein that in addition to descriptive applications, MPNs may be useful for workload estimation and prediction. The results are reported of the first of a series of experiments designed to develop and test a MPN system of workload estimation and prediction. This first experiment is a screening test of MPN model general sensitivity to changes in workload. Positive results from this experiment will justify the more complicated analyses and techniques necessary for developing a workload prediction system. E.R.

**N86-32980*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**LEVELS OF INFORMATION PROCESSING IN A FITTS LAW TASK (LIPFITTS)**

K. L. MOSIER (California Univ., Berkeley.) and S. G. HART *In its* 21st Conference on Manual Control 15 p May 1986

Avail: NTIS HC A22/MF A01 CSCL 05H

State-of-the-art flight technology has restructured the task of human operators, decreasing the need for physical and sensory resources, and increasing the quantity of cognitive effort required, changing it qualitatively. Recent technological advances have the most potential for impacting a pilot in two areas: performance and mental workload. In an environment in which timing is critical, additional cognitive processing can cause performance decrements, and increase a pilot's perception of the mental workload involved. The effects of stimulus processing demands on motor response performance and subjective mental workload are examined, using different combinations of response selection and target acquisition tasks. The information processing demands of the response selection were varied (e.g., Sternberg memory set tasks, math equations, pattern matching), as was the difficulty of the response execution. Response latency as well as subjective workload ratings varied in accordance with the cognitive complexity of the task. Movement times varied according to the difficulty of the response execution task. Implications in terms of real-world flight situations are discussed. Author

**N86-32981*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**THE EFFECTS OF STIMULUS MODALITY AND TASK INTEGRALITY: PREDICTING DUAL-TASK PERFORMANCE AND WORKLOAD FROM SINGLE-TASK LEVELS**

S. G. HART, R. J. SHIVELY, M. A. VIDULICH, and R. C. MILLER (Informatics General Corp., Palo Alto, Calif.) *In its* 21st Annual Conference on Manual Contol 15 p May 1986

Avail: NTIS HC A22/MF A01 CSCL 05H

The influence of stimulus modality and task difficulty on workload and performance was investigated. The goal was to quantify the cost (in terms of response time and experienced workload) incurred when essentially serial task components shared common elements (e.g., the response to one initiated the other) which could be accomplished in parallel. The experimental tasks were based on the Fittsberg paradigm; the solution to a SternBERG-type memory

task determines which of two identical FITTS targets are acquired. Previous research suggested that such functionally integrated dual tasks are performed with substantially less workload and faster response times than would be predicted by suming single-task components when both are presented in the same stimulus modality (visual). The physical integration of task elements was varied (although their functional relationship remained the same) to determine whether dual-task facilitation would persist if task components were presented in different sensory modalities. Again, it was found that the cost of performing the two-stage task was considerably less than the sum of component single-task levels when both were presented visually. Less facilitation was found when task elements were presented in different sensory modalities. These results suggest the importance of distinguishing between concurrent tasks that complete for limited resources from those that beneficially share common resources when selecting the stimulus modalities for information displays. Author

**N86-32982*#** Massachusetts Inst. of Tech., Cambridge. Man-Machine Systems Lab.

**THE IMPACT OF PHYSICAL AND MENTAL TASKS ON PILOT MENTAL WORKOAD**

S. L. BERG and T. B. SHERIDAN *In* NASA. Ames Research Center, 21st Annual Conference on Manual Control 26 p May 1986

Avail: NTIS HC A22/MF A01 CSCL 05H

Seven instrument-rated pilots with a wide range of backgrounds and experience levels flew four different scenarios on a fixed-base simulator. The Baseline scenario was the simplest of the four and had few mental and physical tasks. An activity scenario had many physical but few mental tasks. The Planning scenario had few physical and many mental taks. A Combined scenario had high mental and physical task loads. The magnitude of each pilot's altitude and airspeed deviations was measured, subjective workload ratings were recorded, and the degree of pilot compliance with assigned memory/planning tasks was noted. Mental and physical performance was a strong function of the manual activity level, but not influenced by the mental task load. High manual task loads resulted in a large percentage of mental errors even under low mental task loads. Although all the pilots gave similar subjective ratings when the manual task load was high, subjective ratings showed greater individual differences with high mental task loads. Altitude or airspeed deviations and subjective ratings were most correlated when the total task load was very high. Although airspeed deviations, altitude deviations, and subjective workload ratings were similar for both low experience and high experience pilots, at very high total task loads, mental performance was much lower for the low experience pilots. Author

**N86-32983*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**MEMORY AND SUBJECTIVE WORKLOAD ASSESSMENT**

L. STAVELAND (San Jose State Univ., Calif.), S. HART, and Y. Y. YEH (Illinois Univ., Urbana-Champaign.) *In its* 21st Annual Conference on Manual Control 13 p May 1986

Avail: NTIS HC A22/MF A01 CSCL 05H

Recent research suggested subjective introspection of workload is not based upon specific retrieval of information from long term memory, and only reflects the average workload that is imposed upon the human operator by a particular task. These findings are based upon global ratings of workload for the overall task, suggesting that subjective ratings are limited in ability to retrieve specific details of a task from long term memory. To clarify the limits memory imposes on subjective workload assessment, the difficulty of task segments was varied and the workload of specified segments was retrospectively rated. The ratings were retrospectively collected on the manipulations of three levels of segment difficulty. Subjects were assigned to one of two memory groups. In the Before group, subjects knew before performing a block of trials which segment to rate. In the After group, subjects did not know which segment to rate until after performing the block of trials. The subjective ratings, RTs (reaction times) and MTs (movement times) were compared within group, and between group differences. Performance measures and subjective evaluations of workload reflected the experimental manipulations. Subjects were sensitive to different difficulty levels, and recalled the average workload of task components. Cueing did not appear to help recall, and memory group differences possibly reflected variations in the groups of subjects, or an additional memory task. Author

**N86-32984*#** Idaho Univ., Moscow. Dept. of Engineering Sciences.

**THE EFFECTS OF ACCELERATION STRESS ON HUMAN WORKLOAD AND MANUAL CONTROL**

R. T. GILL, W. B. ALBERY (Aerospace Medical Research Labs., Wright-Patterson AFB, Ohio.), and S. L. WARD *In* NASA. Ames Research Center, 21st Annual Conference on Manual Control 15 p May 1986

Avail: NTIS HC A22/MF A01 CSCL 05H

The effects of +Gz stress on operator task performance and workload were assessed. Subjects were presented a two dimensional maze and were required to solve it as rapidly as possible (by moving a light dot through it via a trim switch on a control stick) while under G-stress at levels from +1 Gz to +6 Gz. The G-stress was provided by a human centrifuge. The effects of this stress were assessed by two techniques; (1) objective performance measures on the primary maze-solving task, and (2) subjective workload measures obtained using the subjective workload assessment technique (SWAT). It was found that while neither moderate (+3 Gz) nor high (+5 Gz and +6 Gz) levels of G-stress affected maze solving performance, the high G levels did increase significantly the subjective workload of the maze task. Author

**N86-32985*#** California Univ., Los Angeles. Dept. of Safety Science and Human Factors.

**KNOWLEDGE-BASED LOAD LEVELING AND TASK ALLOCATION IN HUMAN-MACHINE SYSTEMS**

M. H. CHIGNELL and P. A. HANCOCK *In* NASA. Ames Research Center, 21st Annual Conference on Manual Control 11 p May 1986

Avail: NTIS HC A22/MF A01 CSCL 05H

Conventional human-machine systems use task allocation policies which are based on the premise of a flexible human operator. This individual is most often required to compensate for and augment the capabilities of the machine. The development of artificial intelligence and improved technologies have allowed for a wider range of task allocation strategies. In response to these issues a Knowledge Based Adaptive Mechanism (KBAM) is proposed for assigning tasks to human and machine in real time, using a load leveling policy. This mechanism employs an online workload assessment and compensation system which is responsive to variations in load through an intelligent interface. This interface consists of a loading strategy reasoner which has access to information about the current status of the human-machine system as well as a database of admissible human/machine loading strategies. Difficulties standing in the way of successful implementation of the load leveling strategy are examined. Author

**N86-32986*#** California Univ., Los Angeles. Dept. of Safety Science and Human Factors.

**THE EFFECTS OF STRESS ON ATTENTIONAL RESOURCES Abstract Only**

P. A. HANCOCK and M. H. CHIGNELL *In* NASA. Ames Research Center, 21st Annual Conference on Manual Control 1 p May 1986

Avail: NTIS HC A22/MF A01 CSCL 05H

A new perspective is presented from which to view the action of stress on human behavior. At a behavioral level, the action of stress is related to notions of human attention and an indication of an isomorphic relationship between modes of control at a physiological and behavioral level is presented. Examples of this phenomenon are extracted from performance under heat stress, since this is one of the most simple stress circumstances. It is

suggested that stress sufficient to overcome adaptive capability, that is efficient homeostasis, acts to drain attentional resources. The manner in which such resources fail approximates that function typical of a positive feedback system, which also characterizes the breakdown of physiological response under severe environmental stress. The end point of this draining sequence is the absence of all attentional resources, which is taken to be unconsciousness, to be rapidly followed by the failure of physiological adaptability upon which life sustaining functions depend. This overall picture preserves the inverted-U shaped relationship between stress and performance, yet is in distinct contrast to the traditional arousal account of such behavior. The theoretical and practical ramifications of these observations are explored. Author

**N86-32987*#** Illinois Univ., Savoy. Inst. for Aviation.
**THE EFFECTS OF VOICE AND MANUAL CONTROL MODE ON DUAL TASK PERFORMANCE**
C. D. WICKENS, J. ZENYUH, V. CULP, and W. MARSHAK *In* NASA. Ames Research Center, 21st Annual Conference on Manual Control 1 p May 1986
Avail: NTIS HC A22/MF A01 CSCL 05H

Two fundamental principles of human performance, compatibility and resource competition, are combined with two structural dichotomies in the human information processing system, manual versus voice output, and left versus right cerebral hemisphere, in order to predict the optimum combination of voice and manual control with either hand, for time-sharing performance of a dicrete and continuous task. Eight right handed male subjected performed a discrete first-order tracking task, time-shared with an auditorily presented Sternberg Memory Search Task. Each task could be controlled by voice, or by the left or right hand, in all possible combinations except for a dual voice mode. When performance was analyzed in terms of a dual-task decrement from single task control conditions, the following variables influenced time-sharing efficiency in diminishing order of magnitude, (1) the modality of control, (discrete manual control of tracking was superior to discrete voice control of tracking and the converse was true with the memory search task), (2) response competition, (performance was degraded when both tasks were responded manually), (3) hemispheric competition, (performance degraded whenever two tasks were controlled by the left hemisphere) (i.e., voice or right handed control). The results confirm the value of predictive models invoice control implementation. Author

**N86-32988*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
**EVALUATION OF 2 COGNITIVE ABILITIES TESTS IN A DUAL-TASK ENVIRONMENT**
M. A. VIDULICH and P. S. TSANG *In its* 21st Annual Conference on Manual Control 10 p May 1986
Avail: NTIS HC A22/MF A01 CSCL 05H

Most real world operators are required to perform multiple tasks simultaneously. In some cases, such as flying a high performance aircraft or trouble shooting a failing nuclear power plant, the operator's ability to time share or process in parallel' can be driven to extremes. This has created interest in selection tests of cognitive abilities. Two tests that have been suggested are the Dichotic Listening Task and the Cognitive Failures Questionnaire. Correlations between these test results and time sharing performance were obtained and the validity of these tests were examined. The primary task was a tracking task with dynamically varying bandwidth. This was performed either alone or concurrently with either another tracking task or a spatial transformation task. The results were: (1) An unexpected negative correlation was detected between the two tests; (2) The lack of correlation between either test and task performance made the predictive utility of the tests scores appear questionable; (3) Pilots made more errors on the Dichotic Listening Task than college students. Author

**N86-32989*#** Toronto Univ. (Ontario). Dept. of Industrial Engineering.
**AT LEAST SOME ERRORS ARE RANDOMLY GENERATED (FREUD WAS WRONG)**
A. J. SELLEN and J. W. SENDERS *In* NASA. Ames Research Center, 21st Annual Conference on Manual Control 1 p May 1986
Avail: NTIS HC A22/MF A01 CSCL 05H

An experiment was carried out to expose something about human error generating mechanisms. In the context of the experiment, an error was made when a subject pressed the wrong key on a computer keyboard or pressed no key at all in the time allotted. These might be considered, respectively, errors of substitution and errors of omission. Each of seven subjects saw a sequence of three digital numbers, made an easily learned binary judgement about each, and was to press the appropriate one of two keys. Each session consisted of 1,000 presentations of randomly permuted, fixed numbers broken into 10 blocks of 100. One of two keys should have been pressed within one second of the onset of each stimulus. These data were subjected to statistical analyses in order to probe the nature of the error generating mechanisms. Goodness of fit tests for a Poisson distribution for the number of errors per 50 trial interval and for an exponential distribution of the length of the intervals between errors were carried out. There is evidence for an endogenous mechanism that may best be described as a random error generator. Furthermore, an item analysis of the number of errors produced per stimulus suggests the existence of a second mechanism operating on task driven factors producing exogenous errors. Some errors, at least, are the result of constant probability generating mechanisms with error rate idiosyncratically determined for each subject. Author

**N86-32990*#** Air Line Pilots Association, International, Denison, Tex.
**PILOT INTERFACE WITH FLY BY WIRE CONTROL SYSTEMS**
W. W. MELVIN *In* NASA. Ames Research Center 21st Annual Conference on Manual Control 7 p May 1986
Avail: NTIS HC A22/MF A01 CSCL 05H

Aircraft designers are rapidly moving toward full fly by wire control systems for transport aircraft. Aside from pilot interface considerations such as location of the control input device and its basic design such as side stick, there appears to be a desire to change the fundamental way in which a pilot applies manual control. A typical design would have the lowest order of manual control be a control wheel steering mode in which the pilot is controlling an autopilot. This deprives the pilot of the tactile sense of angle of attack which is inherent in present aircraft by virtue of certification requirements for static longitudinal stability whereby a pilot must either force the aircraft away from its trim angle of attack or trim to a new angle of attack. Whether or not an aircraft actually has positive stability, it can be made to feel to a pilot as though it does by artificial feel. Artificial feel systems which interpret pilot input as pitch rate or G rate with automatic trim have proven useful in certain military combat maneuvers, but their transposition to other more normal types of manual control may not be justified. Author

**N86-32991*#** Systems Technology, Inc., Hawthorne, Calif.
**INVESTIGATION OF LIMB-SIDESTICK DYNAMIC INTERACTION WITH ROLL CONTROL**
D. E. JOHNSTON and D. T. MCRUER *In* NASA. Ames Research Center, 21st Annual Conference on Manual Control 29 p May 1986
(Contract NAS2-11454)
Avail: NTIS HC A22/MF A01 CSCL 05H

A fixed-base simulation was performed to identify and quantify interactions between the pilot's hand/arm neuromuscular subsystem and such features of typical modern fighter aircraft roll rate command control system mechanization as: (1) force sensing side-stick type manipulator; (2) vehicle effective roll time constant; and (3) flight control system effective time delay. The simulation results provide insight to high frequency pilot induced oscillations (PIO) (roll ratchet), low frequency PIO, and roll-to-right control

and handling problems previously observed in experimental and production fly-by-wire control systems. The simulation configurations encompass and/or duplicate several actual flight situations, reproduce control problems observed in flight, and validate the concept that the high frequency nuisance mode known as roll ratchet derives primarily from the pilot's neuromuscular subsystem. The simulations show that force-sensing side-stick manipulator force/displacement/command gradients, command prefilters, and flight control system time delays need to be carefully adjusted to minimize neuromuscular mode amplitude peaking (roll ratchet tendency) without restricting roll control bandwidth (with resulting sluggish or PIO prone control). Author

**N86-32992*#** CAE Electronics Ltd., St. Laurent (Quebec).
**FLIGHT TEST OF A DISPLACEMENT SIDEARM CONTROLLER**
A. L. LIPPAY, R. KRUK, M. KING, and M. MORGAN (National Aeronautical Establishment, Ottawa (Ontario).) *In* NASA. Ames Research Center 21st Annual Conference on Manual Control 23 p May 1986
Avail: NTIS HC A22/MF A01 CSCL 05H

A six-axis displacement-stick sidearm controller was developed to enable single-handed control of remote manipulator operations in space. With a working model available, piloted evaluation became possible in a fly-by-computer variable-stability research aircraft, originally a Bell 205 helicopter. The original mechanization was limited to three rotational axes and a linear one, analogous to the collective stick. A newly designed short stickgrip was mounted and the spring force pattern adjusted to suit the helicopter flight control environment. A standard set of test maneuvers was flown by four experimental pilots with conventional helicopter flight controls and with sidearm controllers equipped with two different handgrips. Existing data from flight tests with an isometric-stick controller were added to complete the comparison. The displacement controller consistently achieved a rating of 3.0 to 3.5 on the Cooper-Harper scale, on par with the conventional controls. The same basic controller design was tested in spacecraft and remote manipulator simulations with very promising results. In each application operator/system integration was rapid and positive. The results demonstrate feasibility and support the design philosphy of using deflection as well as force to generate proprioceptive feedback. Author

**N86-32993*#** Human Engineering Labs., Aberdeen Proving Ground, Md.
**ANTHROPOMETRIC CONSIDERATIONS FOR A 4-AXIS SIDE-ARM FLIGHT CONTROLLER**
W. B. DEBELLIS *In* NASA. Ames Research Center, 21st Annual Conference on Manual Control 14 p May 1986
Avail: NTIS HC A22/MF A01 CSCL 05H

A data base on multiaxis side-arm flight controls was generated. The rapid advances in fly-by-light technology, automatic stability systems, and onboard computers have combined to create flexible flight control systems which could reduce the workload imposed on the operator by complex new equipment. This side-arm flight controller combines four controls into one unit and should simplify the pilot's task. However, the use of a multiaxis side-arm flight controller without complete cockpit integration may tend to increase the pilot's workload. Author

**N86-32994*#** Aerospace Medical Research Labs., Wright-Patterson AFB, Ohio.
**ACTIVE CONTROLLERS AND THE TIME DURATION TO LEARN A TASK**
D. W. REPPERGER and C. GOODYEAR (Systems Research Labs., Inc., Dayton, Ohio.) *In* NASA. Ames Research Center, 21st Annual Conference on Manual Control 12 p May 1986
Avail: NTIS HC A22/MF A01 CSCL 05H

An active controller was used to help train naive subjects involved in a compensatory tracking task. The controller is called active in this context because it moves the subject's hand in a direction to improve tracking. It is of interest here to question whether the active controller helps the subject to learn a task more rapidly than the passive controller. Six subjects, inexperienced to compensatory tracking, were run to asymptote root mean square error tracking levels with an active controller or a passive controller. The time required to learn the task was defined several different ways. The results of the different measures of learning were examined across pools of subjects and across controllers using statistical tests. The comparison between the active controller and the passive controller as to their ability to accelerate the learning process as well as reduce levels of asymptotic tracking error is reported here. Author

**N86-32995*#** California State Univ., Hayward.
**HESITATION IN TRACKING INDUCED BY A CONCURRENT MANUAL TASK**
P. A. KELLY and S. T. KLAPP *In* NASA. Ames Research Center, 21st Annual Conference on Manual Control 3 p May 1986 (Contract NCC2-223)
Avail: NTIS HC A22/MF A01 CSCL 05H

When people are required to track with one hand and perform occasional discrete responses with the other hand, there is a strong possibility that errors will be induced in tracking attributable to the simultaneous action by the other. This problem was investigated by pairing pursuit tracking (right hand) with a handle movement response (left hand) guided by an auditory stimulus. Tracking is assumed to represent flight control and the left hand response to represent other aspects of aircraft system management. The general goal of this research is to identify the types of errors induced into tracking by the requirement of a secondary response with the other hand. An attempt is reported to determine if hesitations can be reduced further by combining tracking emphasis with a higher degree of practice. It is concluded that there is a tendency to freeze the tracking response when a discrete simultaneous response is required of the other hand. By contrast, practice seems to reduce hesitations while also improving left hand reaction time. Thus there appears to be a mode of control which permits tracking and discrete simultaneous responses to occur together. Author

**N86-32996*#** Ohio State Univ., Columbus. Dept. of Psychology.
**PROGRESSION-REGRESSION EFFECTS IN TRACKING REPEATED PATTERNS Abstract Only**
R. J. JAGACINSKI and S. HAH *In* NASA. Ames Research Center, 21st Annual Conference on Manual Control 1 p May 1986
Avail: NTIS HC A22/MF A01 CSCL 05H

Subjects used a position control system to perform compensatory tracking of a repeated input pattern. The input pattern was 20 seconds in duration and was either an arctangent function or the sum of two sine waves. Tracking error decreased with practice and increased with the addition of a concurrent memory task. The shape of the ensemble-average tracking error resembled the shape of the input velocity signal throughout these changes in performance. Regression analyses were used to parameterize these effects and compare these results with the predictions of several conceptualizations of perceptual-motor learning. Author

**N86-32997*#** Illinois Univ., Urbana. Biomechanics Lab.
**THE ROLE OF IMPULSE PARAMETERS IN FORCE VARIABILITY**
L. G. CARLTON and K. M. NEWELL (Illinois Univ., Urbana-Champaign.) *In* NASA. Ames Research Center, 21st Annual Conference on Manual Control 9 p May 1986
Avail: NTIS HC A22/MF A01 CSCL 05H

One of the principle limitations of the human motor system is the ability to produce consistent motor responses. When asked to repeatedly make the same movement, performance outcomes are characterized by a considerable amount of variability. This occurs whether variability is expressed in terms of kinetics or kinematics. Variability in performance is of considerable importance because for tasks requiring accuracy it is a critical variable in determining the skill of the performer. What has long been sought is a description of the parameter or parameters that determine the degree of variability. Two general experimental protocals were used.

One protocal is to use dynamic actions and record variability in kinematic parameters such as spatial or temporal error. A second strategy was to use isometric actions and record kinetic variables such as peak force produced. What might be the important force related factors affecting variability is examined and an experimental approach to examine the influence of each of these variables is provided. E.R.

**N86-32998*#** Toronto Univ. (Ontario). Dept. of Industrial Engineering.

**HITTS LAW? A TEST OF THE RELATIONSHIP BETWEEN INFORMATION LOAD AND MOVEMENT PRECISION**

M. ZALESKI and N. MORAY *In* NASA. Ames Research Center 21st Annual Conference on Manual Control 21 p May 1986 (Contract NAGW-429)

Avail: NTIS HC A22/MF A01 CSCL 05H

Recent technological developments have made viable a man-machine interface heavily dependent on graphics and pointing devices. This has led to new interest in classical reaction and movement time work by Human Factors specialists. Two experiments were designed and run to test the dependence of target capture time on information load (Hitt's Law) and movement precision (Fitts' Law). The proposed model linearly combines Hitt's and Fitts' results into a combination law which then might be called Hitts' Law. Subjects were required to react to stimuli by manipulating a joystick so as to cause a cursor to capture a target on a CRT screen. Response entropy and the relative precision of the capture movement were crossed in a factorial design and data obtained that were found to support the model. Author

**N86-32999*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**AIRCREW COORDINATION AND DECISIONMAKING: PEER RATINGS OF VIDEO TAPES MADE DURING A FULL MISSION SIMULATION**

M. R. MURPHY and C. A. AWE (San Jose State Univ., Calif.) *In its* 21st Annual Conference on Manual Control 33 p May 1986

Avail: NTIS HC A22/MF A01 CSCL 05H

Six professionally active, retired captains rated the coordination and decisionmaking performances of sixteen aircrews while viewing videotapes of a simulated commercial air transport operation. The scenario featured a required diversion and a probable minimum fuel situation. Seven point Likert-type scales were used in rating variables on the basis of a model of crew coordination and decisionmaking. The variables were based on concepts of, for example, decision difficulty, efficiency, and outcome quality; and leader-subordin ate concepts such as person and task-oriented leader behavior, and competency motivation of subordinate crewmembers. Five-front-end variables of the model were in turn dependent variables for a hierarchical regression procedure. The variance in safety performance was explained 46%, by decision efficiency, command reversal, and decision quality. The variance of decision quality, an alternative substantive dependent variable to safety performance, was explained 60% by decision efficiency and the captain's quality of within-crew communications. The variance of decision efficiency, crew coordination, and command reversal were in turn explained 78%, 80%, and 60% by small numbers of preceding independent variables. A principle component, varimax factor analysis supported the model structure suggested by regression analyses. Author

**N86-33000*#** Connecticut Univ., Storrs. Dept. of Electrical Engineering and Computer Scien

**AN EXPERIMENTAL PARADIGM FOR TEAM DECISION PROCESSES**

D. SERFATY and D. L. KLEINMAN *In* NASA. Ames Research Center, 21st Annual Conference on Manual Control 2en1] p May 1986

Avail: NTIS HC A22/MF A01 CSCL 05H

The study of distributed information processing and decision making is presently hampered by two factors: (1) The inherent complexity of the mathematical formulation of decentralized problems has prevented the development of models that could be used to predict performance in a distributed environment; and (2) The lack of comprehensive scientific empirical data on human team decision making has hindered the development of significant descriptive models. As a part of a comprehensive effort to find a new framework for multihuman decision making problems, a novel experimental research paradigm was developed involving human terms in decision making tasks. Attempts to construct parts of an integrated model with ideas from queueing networks, team theory, distributed estimation and decentralized resource management are described. Author

**N86-33001*#** Ohio State Univ., Columbus. Dept. of Industrial and Systems Engineering.

**INVESTIGATION OF CREW PERFORMANCE IN A MULTI-VEHICLE SUPERVISORY CONTROL TASK Abstract Only**

R. A. MILLER, B. D. PLAMONDON, R. J. JAGACINSKI, and A. C. KIRLIK *In* NASA. Ames Research Center, 21st Annual Conference on Manual Control 1 p May 1986

Avail: NTIS HC A22/MF A01 CSCL 05H

Crew information processing and decision making in a supervisory control task which is loosely based on the mission of future generation helicopters is measured and represented. Subjects control the motion and activities of their own vehicle and direct the activities of four additional craft. The task involves searching an uncertain environment for cargo and enemies, returning cargo to home base and destroying enemies while attempting to avoid destruction of the scout and the supervised vehicles. A series of experiments with two-person crews and one-person crews were performed. Resulting crew performance was modeled with the objective of describing and understanding the information processing strategies utilized. Of particular interest are problem simplification strategies under time stress and high work load, simplification and compensation in the one-person cases, crew coordination in the two-person cases, and the relationship between strategy and errors in all cases. The results should provide some insight into the effective use of aids, particularly aids based on artificial intelligence, for similar tasks. The simulation is described which is used for the study and some preliminary results from the first two-person crew study are discussed. Author

**N86-33002*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.

**FORCE/TORQUE DISPLAY FOR SPACE TELEOPERATION CONTROL EXPERIMENTS AND EVALUATION**

K. CORKER (Bolt, Beranek, and Newman, Inc., Cambridge, Mass.), A. BEJCZY, and B. RAPPAPORT *In* NASA. Ames Research Center, 21st Annual Conference on Manual Control 24 p May 1986

Avail: NTIS HC A22/MF A01 CSCL 05H

Experiments were performed at the Johnson Space Center (JSC), Manipulator Development Facility using the full scale Shuttle Remote Manipulator System (SRMS) to evaluate the effect of visual presentation through perspective display of the orthogonal forces and torques sensed at the manipulator end effector. The experiments investigated the effect of the display information on the management of forces and torques generated during payload berthing and deployment, as well as simulated satellite module change-out operations. The evaluation also addressed (1) issues of display format, including: force/torque scaling, point of resolution, and display mixing with video generated imagery, and (20) task related variables of payload size, alternative sources of guidance information, and control mode. The results are presented of a first-pass informal anlaysis of the analog, strip chart-recorded data from these evaluation tests. The results provide a relative measure of improvement in force management through the use of such a display, as well as information regarding the impact of display variables and task demands on operator performance. Author

**N86-33003*#** National Aerospace Lab., Amsterdam (Netherlands).
**MODEL ANALYSIS OF REMOTELY CONTROLLED RENDEZVOUS AND DOCKING WITH DISPLAY PREDICTION**
P. MILGRAM and P. H. WEWERINKE *In* NASA. Ames Research Center, 21st Annual Conference on Manual Control 18 p May 1986
(Contract ESA-5594/83/NL/AN(SC))
Avail: NTIS HC A22/MF A01 CSCL 05H

Manual control of rendezvous and docking (RVD) of two spacecraft in low earth orbit by a remote human operator is discussed. Experimental evidence has shown that control performance degradation for large transmission delays (between spacecraft and operations control center) can be substantially improved by the introduction of predictor displays. An intial Optimal Control Model (OCM) analysis of RVD translational and rotational perturbation control was performed, with emphasis placed on the predictive capabilities of the combined Kalman estimator/optimal predictor with respect to control performance, for a range of time delays, motor noise levels and tracking axes. OCM predictions are then used as a reference for comparing tracking performance with a simple predictor display, as well as with no display prediction at all. Use is made here of an imperfect internal model formulation, whereby it is assumed that the human operator has no knowledge of the system transmission delay. Author

**N86-33004*#** California Univ., Davis. Dept. of Mechanical Engineering.
**A MODEL FOR THE HUMAN'S USE OF VISUAL FIELD CUES IN NAP-OF-THE-EARTH FLIGHT Abstract Only**
R. A. HESS and K. CHAN *In* NASA. Ames Research Center, 21st Annual Conference on Manual Control 1 p May 1986
Avail: NTIS HC A22/MF A01 CSCL 05H

A simple model is developed which describes the manner in which the human pilot may use visual field cues in controlling a vehicle in nap-of-the earth flight. The model is based upon the feedforward of information obtained from streamer patterns in the visual field to the inner-most loop of a multi-loop pilot/vehicle model. In this framework, the model is a logical extension of pursuit and preview models of the human operator which have appeared in the literature. Simulation and flight test data involving low-level helicopter flight tasks are applied to model development and validation. Author

**N86-33005*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
**VIRTUAL SPACE AND 2-DIMENSIONAL EFFECTS IN PERSPECTIVE DISPLAYS**
M. W. MCGREEVY, C. R. RATZLAFF (San Jose State Univ., Calif.), and S. R. ELLIS *In its* 21st Annual Conference on Manual Control 14 p May 1986
Avail: NTIS HC A22/MF A01 CSCL 05H

When interpreting three dimensional spatial relationships presented on a two dimensional display surface, the viewer is required to mentally reconstruct the original information. This reconstruction is influenced by both the perspective geometry of the displayed image and the viewer's eye position relative to the display. In a study which manipulated these variables, subjects judged the azimuth direction of a target object relative to a reference object fixed in the center of a perspective display. The results support a previously developed model which predicted that the azimuth judgement error would be a sinusoidal function of stimulus azimuth. The amplitude of this function was correctly predicted to be systematically modulated by both the perspective geometry of the image and the viewer's eye position relative to the screen. Interaction of the two components of the model, the virtual space effect and the 3D-to-2D projection effect, predicted the relative amplitudes of the sinusoidal azimuth error functions for the various conditions of the experiment. Mean azimuth judgements in some directions differed by as much as 25 degrees as a result of different combinations of eye position and image geometry. The results illustrate the need to consider the effects of perspective geometry when designing spatial information instruments, and show the model to be a reliable predictor of average performance. Author

**N86-33006*#** Purdue Univ., West Lafayette, Ind. School of Aeronautics and Astronautics.
**OPTIMAL COOPERATIVE CONTROL SYNTHESIS OF ACTIVE DISPLAYS**
S. GARG and D. K. SCHMIDT *In* NASA. Ames Research Center, 21st Annual Conference on Manual Control 18 p May 1986
(Contract NAG2-228)
Avail: NTIS HC A22/MF A01 CSCL 05H

The utility of augmenting displays to aid the human operator in controlling high order complex systems is well known. Analytical evaluation of various display designs for a simple k/s sup 2 plant in a compensatory tracking task using an optimal Control Model (OCM) of human behavior is carried out. This analysis reveals that significant improvement in performance should be obtained by skillful integration of key information into the display dynamics. The cooperative control synthesis technique previously developed to design pilot-optimal control augmentation is extended to incorporate the simultaneous design of performance enhancing augmented displays. The application of the cooperative control synthesis technique to the design of augmented displays is discussed for the simple k/s sup 2 plant. This technique is intended to provide a systematic approach to design optimally augmented displays tailored for specific tasks. Author

**N86-33007*#** Bolt, Beranek, and Newman, Inc., Cambridge, Mass.
**SOME COMPUTATIONAL TECHNIQUES FOR ESTIMATING HUMAN OPERATOR DESCRIBING FUNCTIONS**
W. H. LEVISON *In* NASA. Ames Research Center 21st Annual Conference on Manual Control 21 p May 1986
Avail: NTIS HC A22/MF A01 CSCL 05H

Computational procedures for improving the reliability of human operator describing functions are described. Special attention is given to the estimation of standard errors associated with mean operator gain and phase shift as computed from an ensemble of experimental trials. This analysis pertains to experiments using sum-of-sines forcing functions. Both open-loop and closed-loop measurement environments are considered. Author

**N86-33008*#** Systems Technology, Inc., Hawthorne, Calif.
**MANUAL CONTROL OF UNSTABLE SYSTEMS**
R. W. ALLEN, J. R. HOGUE, and Z. PARSEGHIAN *In* NASA. Ames Research Center, 21st Annual Conference on Manual Control 18 p May 1986
Avail: NTIS HC A22/MF A01 CSCL 05H

Under certain operational regimes and failure modes, air and ground vehicles can present the human operator with a dynamically unstable or divergent control task. Research conducted over the last two decades has explored the ability of the human operator to control unstable systems under a variety of circumstances. Past research is reviewed and human operator control capabilities are summarized. A current example of automobile directional control under rear brake lockup conditions is also reviewed. A control system model analysis of the driver's steering control task is summarized, based on a generic driver/vehicle model presented at last year's Annual Manual. Results from closed course braking tests are presented that confirm the difficulty the average driver has in controlling the unstable directional dynamics arising from rear wheel lockup. Author

**N86-33009*#** Purdue Univ., West Lafayette, Ind. School of Aeronautics and Astronautics.
**MODIFIED SUPERPOSITION: A SIMPLE TIME SERIES APPROACH TO CLOSED-LOOP MANUAL CONTROLLER IDENTIFICATION**
D. J. BIEZAD, D. K. SCHMIDT, F. LEBAN, and S. MASHIKO *In* NASA. Ames Research Center, 21st Annual Conference on Manual Control 30 p May 1986
Avail: NTIS HC A22/MF A01 CSCL 05H

Single-channel pilot manual control output in closed-tracking tasks is modeled in terms of linear discrete transfer functions which are parsimonious and guaranteed stable. The transfer functions are found by applying a modified super-position time series generation technique. A Levinson-Durbin algorithm is used to determine the filter which prewhitens the input and a projective (least squares) fit of pulse response estimates is used to guarantee indentified model stability. Results from two case studies are compared to previous findings, where the source of data are relatively short data records, approximately 25 seconds long. Time delay effects and pilot seasonalities are discussed and analyzed. It is concluded that single-channel time series controller modeling is feasible on short records, and that it is important for the analyst to determine a criterion for best time domain fit which allows association of model parameter values, such as pure time delay, with actual physical and physiological constraints. The purpose of the modeling is thus paramount. Author

**N86-33010*#** Systems Technology, Inc., Hawthorne, Calif.
**COMPARISON OF THE STI NIPIP TRACKING DYNAMICS IDENTIFICATION WITH THE ON-LINE FOURIER ANALYZER DFA RESULTS INCLUDING A TIME VARYING CASE**
H. R. JEX and G. HANSON *In* NASA. Ames Research Center, 21st Annual Conference on Manual Control 7 p May 1986 (Contract F33615-82-C-0629)
Avail: NTIS HC A22/MF A01 CSCL 05H

The Non-Intrusive Pilot Identification Procedure (NIPIP) recently developed at STI and described at the 1981 Annual Manual was used to identify operators who were compensatory tracking a sub-critical-instability task. NIPIP uses a time domain least squares procedure converting to frequency domain coefficients. The forcing function was a sum of sinusoids supplied by the STI Mark II Describing Function Analyzer, which computes on-line Fourier coefficients of the operator's error/input describing function. The resulting open-loop and operator dynamics computed by each procedure are compared, and they are shown to be reasonably close when there is reasonable power in the error signal at the measurement frequencies. A special run was made in which the operator abruptly reduced gain within 1 sec, and the ability of the NIPIP to identify this step time variation in the operator is illustrated. Author

**N86-33011*#** Institut fuer Flugmechanik, Brunswick (West Germany).
**A FLIGHT TEST METHOD FOR PILOT/AIRCRAFT ANALYSIS**
R. KOEHLER and E. BUCHACKER *In* NASA. Ames Research Center, 21st Annual Conference on Manual Control 14 p May 1986
Avail: NTIS HC A22/MF A01 CSCL 05H

In high precision flight maneuvres a pilot is a part of a closed loop pilot/aircraft system. The assessment of the flying qualities is highly dependent on the closed loop characteristics related to precision maneuvres like approach, landing, air-to-air tracking, air-to-ground tracking, close formation flying and air-to air refueling of the receiver. The object of a research program at DFVLR is the final flight phase of an air to ground mission. In this flight phase the pilot has to align the aircraft with the target, correct small deviations from the target direction and keep the target in his sights for a specific time period. To investigate the dynamic behavior of the pilot-aircraft system a special ground attack flight test technique with a prolonged tracking maneuvres was developed. By changing the targets during the attack the pilot is forced to react continously on aiming errors in his sights. Thus the closed loop pilot/aircraft system is excited over a wide frequency range of interest, the pilot gets more information about mission oriented aircraft dynamics and suitable flight test data for a pilot/aircraft analysis can be generated. Author

**N86-33012*#** Northrop Corp., Hawthorne, Calif. Aircraft Div.
**MAXIMUM NORMALIZED ACCELERATION AS A FLYING QUALITIES PARAMETER**
J. S. WARNER and E. D. ONSTOTT *In* NASA. Ames Research Center, 21st Annual Conference on Manual Control 11 p May 1986
Avail: NTIS HC A22/MF A01 CSCL 05H

In 1984, Maximum Normalized Rate (MNR) was presented as a Flying Qualities parameter. Subsequent analysis of data from ground based simulation and flight test revealed the utility of a companion parameter, Maximum Normalized Acceleration (MNA). MNR and MNA profiles reveal the presence of both continuous and pulsed compensation strategies during discrete attitude tracking. In addition, MNR appears to be a suitable metric for pilot opinion in the LATHOS data base, while the MNR/MNA relationship is sensitive to pilot-induced-oscillation (PIO) and roll ratcheting problems. As part of an investigation of this problem, Northrop has developed an analysis technique known as the Step Target Method. The Step Target method is essentially a one degree-of-freedom simulation, where an attitude command in the form of a step function is presented to a closed-loop pilot/aircraft model. The two parameters MNR and MNA were shown to be useful in Flying Qualities analysis. MNR was shown to correlate with Pilot Opinion Rating in the LATHOS data base, while MNA reflects PIO and roll ratcheting. Profiles of MNR versus MNA reveal the presence of pulsed compensation strategies in both ground based and in-flight simulation. Furthermore, comparison of continuous and discrete attitude tracking simulation data reveals that these two tracking tasks exhibit independent sensitivities to aircraft characteristics. E.R.

**N86-33013*#** Purdue Univ., West Lafayette, Ind. School of Aeronautics and Astronautics.
**CLOSED-LOOP, PILOT/VEHICLE ANALYSIS OF THE APPROACH AND LANDING TASK**
M. R. ANDERSON and D. K. SCHMIDT *In* NASA. Ames Research Center, 21st Annual Conference on Manual Control 5 p May 1986
Avail: NTIS HC A22/MF A01 CSCL 05H

In the case of approach and landing, it is universally accepted that the pilot uses more than one vehicle response, or output, to close his control loops. Therefore, to model this task, a multi-loop analysis technique is required. The analysis problem has been in obtaining reasonable analytic estimates of the describing functions representing the pilot's loop compensation. Once these pilot describing functions are obtained, appropriate performance and workload metrics must then be developed for the landing task. The optimal control approach provides a powerful technique for obtaining the necessary describing functions, once the appropriate task objective is defined in terms of a quadratic objective function. An approach is presented through the use of a simple, reasonable objective function and model-based metrics to evaluate loop performance and pilot workload. The results of an analysis of the LAHOS (Landing and Approach of Higher Order Systems) study performed by R.E. Smith is also presented. Author

**N86-33014#** Southampton Univ. (England). Inst. of Sound and Vibration Research.
**A DESIGN GUIDE FOR VISUAL DISPLAYS AND MANUAL TASKS IN VIBRATION ENVIRONMENTS. PART 1: VISUAL DISPLAYS**
M. J. MOSELEY and M. J. GRIFFIN May 1986 34 p
(ISVR-TR-133-PT-1) Avail: NTIS HC A03/MF A01

Design guidance relevant to the effects of vibration on visual tasks is provided. The vibration shows how effects are related to characteristics of the vibration, the display, and other aspects of the environment. Published experimental studies are used as the basis of a series of design recommendations which may be used to minimize the influence of vibration on visual tasks. Author

**N86-33015#** Southampton Univ. (England). Inst. of Sound and Vibration Research.
**A DESIGN GUIDE FOR VISUAL DISPLAYS AND MANUAL TASKS IN VIBRATION ENVIRONMENTS. PART 2: MANUAL TASKS**
R. W. MCLEOD and M. J. GRIFFIN May 1986 36 p
(ISVR-TR-134) Avail: NTIS HC A03/MF A01

Design guidance relevant to the effects of vibration on manual activities is provided. The information describes the mechanisms by which vibration may affect task performance and shows how effects are dependent upon characteristics of both the vibration environment and the task. Data from published experimental studies are used as the basis of a series of design recommendations which may be used to minimize the influence of vibration on manual tasks. Author

**N86-33016*#** Stanford Univ., Calif. Dept. of Aeronautics and Astronautics.
**CONTROL OF A FREE-FLYING ROBOT MANIPULATOR SYSTEM Semiannual Report, Feb. - Jul. 1985**
H. ALEXANDER and R. H. CANNON, JR. Jul. 1985 8 p
(Contract NCC2-333)
(NASA-CR-179717; NAS 1.26:179717; SAR-1) Avail: NTIS HC A02/MF A01 CSCL 05H

The goal of the research is to develop and test control strategies for a self-contained, free flying space robot. Such a robot would perform operations in space similar to those currently handled by astronauts during extravehicular activity (EVA). The focus of the work is to develop and carry out a program of research with a series of physical Satellite Robot Simulator Vehicles (SRSV's), two-dimensionally freely mobile laboratory models of autonomous free-flying space robots such as might perform extravehicular functions associated with operation of a space station or repair of orbiting satellites. The development of the SRSV and of some of the controller subsystems are discribed. The two-link arm was fitted to the SRSV base, and researchers explored the open-loop characteristics of the arm and thruster actuators. Work began on building the software foundation necessary for use of the on-board computer, as well as hardware and software for a local vision system for target identification and tracking. Author

**N86-33017#** Department of the Navy, Washington, D. C.
**AUTOMATED ANTHROPOMETRIC DATA MEASUREMENT SYSTEM Patent Application**
W. F. MORONEY, J. C. BARTHOLOMEW, C. CAGLE, and R. E. HUGHES, inventors (to Navy) 17 Oct. 1985 20 p
(AD-D012299; US-PATENT-APPL-SN-788371) Avail: NTIS HC A02/MF A01 CSCL 06N

An automated anthropometric data measurement system includes a standing measuring assembly and a seated measuring assembly to determine pertinent anthropometric features of aviators being screened for assignment to particularly suitable aircraft. Both assemblies have a plurality of position sensors and measuring probes which are selectively placed by an operator upon the aviator, each mesuring probe producing a digital data signal indicative of the particular feature measured when selective position sensors indicate body contact. The signals are then collected by a microcomputer which compares them to a predetermined population and outputs the compared data to magnetic storage media. GRA

**N86-33018#** Department of the Air Force, Washington, D.C.
**NIGHT VISION COMPATIBLE ILLUMINATION FOR VEHICLE CREWMEMBER WORKSPACE Patent**
H. L. TASK, inventor (to Air Force) 1 Apr. 1986 8 p Supersedes AD-D011636
(AD-D012339; US-PATENT-4,580,196;
US-PATENT-APPL-SN-688944; US-PATENT-CLASS-362-62)
Avail: US Patent and Trademark Office CSCL 13A

This patent discloses an arrangement for conveniently changing the illumination in an aircraft cockpit or other enclosure to a spectrum compatible with night vision infrared equipment including provision for easy return to the original illumination source. Selected light emitting diode elements are employed in multiple element arrays using a tether connected package that can be excited directly from existing wiring in fixtures. GRA

**N86-33019#** Aerospace Medical Research Labs., Wright-Patterson AFB, Ohio.
**A COLLATION OF UNITED STATES AIR FORCE ANTHROPOMETRY**
K. W. KENNEDY 14 Jan. 1986 92 p
(AD-A168485; AAMRL-TR-85-062) Avail: NTIS HC A05/MF A01 CSCL 06N

Four major anthropometric surveys of United States Air Force personnel have been conducted since the end of World War II: that of male rated and non-rated flying personnel in 1950, of male recruits, enlisted and non-rated officers in 1965, of male rated officers and cadets in 1967, and of female officers and enlisted in 1968. Only two surveys have been adequately published: those of 1950 and 1968. For the purposes of this collation, four USAF subpopulations have been distinguished: (1) non-rated male officers and enlisted (2) rated male officers and cadets, (3) non-rated female officers and enlisted personnel, and (4) rated female officers and cadets. The latter is an artificial subset of women taken form the 1968 survey and who meet the Air Force body-size criteria for entry into Undergraduate Pilot Training and retention as a rated officer. Dimension titles and descriptions are listed alphabetically and cross referenced such that the user can be quickly directed to the desired or to related body size data. Summary statistics consists of the number of subjects measured, the Mean, Standard Deviation, and the 1st, 5th, 50th, 95th, and 99th percentile values for each dimension. GRA

**N86-33020#** Naval Air Development Center, Warminster, Pa. Aircraft and Crew Systems Technology Directorate.
**THE DEVELOPMENT AND EVALUATION OF COLOR SYSTEMS FOR AIRBORNE APPLICATIONS: FUNDAMENTAL VISUAL, PERCEPTUAL AND DISPLAY SYSTEMS CONSIDERATIONS Final Report, Oct. 1984 - Feb. 1986**
R. M. MERRIFIELD and L. D. SILVERSTEIN Feb. 1986 333 p
(AD-A168563; NADC-86011-60) Avail: NTIS HC A15/MF A01 CSCL 05H

The objectives of the study were to review the current philosophy and standards on the airborne applications of electronic color display systems, develop guidelines for specifying and measuring color CRT display performance parameters, conduct a survey of currently available color systems, review and evaluate existing system capabilities, and predict future trends and applications in color display systems and componentry. Partial Contents are: Analysis of the Current Philosophy and Standards on the Application of Color in Electronic Display Systems (Principal Factors Determining Color Display Effectiveness; Color Display Specification, Measurement, and Calibration Techniques; Impact of the Operational Lighting Environment on Color Display Requirements; Unresolved Issues and Future Color Display Research Requirements); Survey and Evaluation of Currently Available Color Display Systems (Technical Evaluation of Hardware Characteristics and Visual Parameters; Summary Recommendations; Prediction of Future Trends and Development in Color Display Technology). GRA

**N86-33021#** School of Aerospace Medicine, Brooks AFB, Tex.
**EFFECT OF OXYGEN FLOW ON PASSENGER FACE MASK PERFORMANCE Final Report, Jan. 1984 - May 1985**
R. D. HOLDEN, M. S. HASWELL, and E. M. FORSTER Apr. 1986 23 p
(AD-A168832; USAFSAM-TR-85-102) Avail: NTIS HC A02/MF A01 CSCL 06K

The passenger emergency oxygen system presently used onboard USAF transort aircraft is a phase dilution continuous flow system, and is similar to that on commercial aircraft. The mask is certified for emergency use up to 40,000 ft, when provided with an oxygen flow in accord with military specifications (MIL-D-19326F). We have evaluated the effect on arterial hemoglobin saturation (SaO2), of reductions in oxygen flow (below

those specified) to the emergency mask; the volunteer subjects were exposed to simulated altitudes of 40, 35, 30 and 25 thousand feet. At reduced oxygen flows to the emergency pasenger mask, SaO2, was: 88 + or - 2.8%, 92 + or - 3.5%, 98 + or - 1.2%, and 97 + or - 1.0%; at 40, 35, 30, and 25 thousand ft respectively. Although halving the oxygen flow to the mask at 25,000 ft and 30,000 ft resulted in acceptable levels of SaO2, reductions in flow--at 35,000 ft and, especially, at 40,000 ft--were not as well tolerated. at 40,000 ft and, to a lesser extent, 35,000 ft, inboard leakage of ambient air around the face and through the anti-suffocation valve seriously compromised SaO2, Because passengers suddenly exposed to a 40,000-ft cabin altitude would undoubtedly suffer from anxiety and would tend to hyperventilate, and because of limitations inherent in continuous flow oxygen systems, we recommend that oxygen flow to the passenger mask (as specified in MIL-D-19326F) be reduced with great caution.
GRA

**N86-33022#** Naval Coastal Systems Center, Panama City, Fla.
**ELEMENTARY DESIGN GUIDELINES FOR CO2 SCRUBBING WITH LIOH, TECHNICAL MANUAL**
D. B. POST Dec. 1985 22 p
(AD-A168850; NCSC-TM-4110-2-85) Avail: NTIS HC A02/MF A01 CSCL 06K

The removal of carbon dioxide from closed-cycle gaseous environments is essential to keeping people alive in an environment such as a submarine, a gas saturation habitat on the floor of the ocean, or a diver using closed-circuit UBAs. If the CO2 were not removed from these environments, its concentration would soon rise to toxic and lethal proportions. The removal of CO2 from these environments is commonly referred to as CO2 scrubbing and its purpose is to lower the CO2 concentrations to physiologically acceptable levels. This technical manual contains a brief outline of preliminary laboratory work leading up to NAVCOASTSYSCEN's investigation of LiOH for scrubbing CO2, theoretical considerations of the reaction of CO2 with LiOH, a description of the procedure and apparatus used to collect the LiOH-CO2 scrubber data, elementary design equations to predict canister efficiency, an example problem using results presented earlier in the manual, and practical considerations concerning the theoretical design of CO2 scrubbers.
GRA

**N86-33023#** Lawrence Livermore National Lab., Calif.
**HUMAN FACTORS REVIEW PLAN**
B. PARAMORE, ed. and L. R. PETERSON, ed. Dec. 1985 261 p Prepared in cooperation with Essex Corp., Alexandria, Va.
(Contract W-7405-ENG-48)
(DE86-010561; UCRL-15688) Avail: NTIS HC A12/MF A01

Human Factors is concerned with the incorporation of human user considerations into a system in order to maximize human reliability and reduce errors. This review plan is intended to assist in the assessment of human factors conditions in existing DOE facilities. In addition to specifying assessment methodologies, the plan describes techniques for improving conditions which are found to not adequately support reliable human performance. The following topics are addressed: (1) selection of areas for review describes techniques for needs assessment to assist in selecting and prioritizing areas for review; (2) human factors engineering review is concerned with optimizing the interfaces between people and equipment and people and their work environment; (3) procedures review evaluates completeness and accuracy of procedures, as well as their usability and management; (4) organizational interface review is concerned with communication and coordination between all levels of an organization; and (5) training review evaluates training program criteria such as those involving: trainee selection, qualification of training staff, content and conduct of training, requalification training, and program management.
DOE

**N86-33024#** National Aerospace Lab., Amsterdam (Netherlands). Space Div.
**CONTROL LOOPS WITH HUMAN OPERATORS IN SPACE OPERATIONS. PART 2: ROBOTICS OPERATIONS AND MANUAL CONTROL EXPERIMENT Final Report**
C. M. VANSWIETEN and S. KAMPEN Paris ESA 5 Sep. 1985 140 p Prepared in cooperation with Royal Netherlands Aircraft Factories Fokker, Amsterdam
(Contract ESA-5594/83)
(NLR-TR-84116-L-PT-2; FOK-TR-R-84-CHO-131-PT-2; ESA-CR(P)-2190-PT-2; ETN-86-97788-PT-2) Avail: NTIS HC A07/MF A01

Servicing of satellites and assembly of space structures via robotic operations controlled from the ground by human operators are discussed. Five operational modes for the combined space and ground segment are defined: high level manipulation; manual augmented; preprogrammed; single joint (emergency mode); and direct drive (emergency mode). The main difficulty in the manual modes is the presence of time delay in the control loop and the way the operator can cope with it. Human operator performance was assessed for the direct drive mode, in which the system provides the least support. A simple model for this mode shows essentially nonlinear actuator behavior, which makes results from the literature not applicable. Therefore experiments were done. The experiments show that the operator can control the system, but a lot of overshooting responses are observed. Possibly, these overshoots can be eliminated by different instructions to the operator, who was instructed in the experiments to be as fast as possible.
ESA

## 55

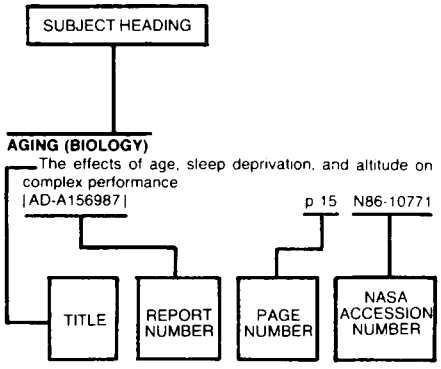
## PLANETARY BIOLOGY

Includes exobiology; and extraterrestrial life.

**N86-32111*#** State Univ. of New York, Binghamton. Dept. of Biological Sciences.
**EVALUATION OF THE NEED FOR A LARGE PRIMATE RESEARCH FACILITY IN SPACE**
F. M. SULZMAN 1986 50 p
(Contract NAG2-232)
(NASA-CR-179661; NAS 1.26:179661) Avail: NTIS HC A03/MF A01 CSCL 06B

In the summer of 1983, an advisory committe was organized that would be able to evaluate NASA's current and future capabilities for nonhuman primate research in space. Individuals were chosen who had experience in four key research areas: cardiovascular physiology, vestibular neurophysiology, musculo-skeletal physiology, and fluid and electrolyte balance. Recommendations of the committee to NASA are discussed.
B.G.

## Typical Subject Index Listing




The subject heading is a key to the subject content of the document. The title is used to provide a description of the subject matter. When the title is insufficiently descriptive of the document content, the title extension is added, separated from the title by three hyphens. The (NASA or AIAA) accession number and the page number are included in each entry to assist the user in locating the abstract in the abstract section. If applicable, a report number is also included as an aid in identifying the document. Under any one subject heading, the accession numbers are arranged in sequence with the AIAA accession numbers appearing first.

## A

**ABILITIES**
Evaluation of 2 cognitive abilities tests in a dual-task environment p 438 N86-32988
**ACCELERATION PROTECTION**
An engineering test and evaluation of several new anti-G valves --- for high performance fighter aircraft p 430 A86-47734
Current research on advanced concept anti-G suits p 431 A86-47747
Development of a mechanical analog of a human spine and viscera p 418 A86-47753
Single stage rapid response anti-G valve p 432 A86-47762
Anti-G suit protection and body position p 432 A86-47764
**ACCELERATION STRESSES (PHYSIOLOGY)**
The effects of acceleration stress on human workload and manual control p 437 N86-32984
**ACCELERATION TOLERANCE**
Effects of -Gz centrifugal acceleration upon cardiac output of hamster p 415 A86-50290
**ACCLIMATIZATION**
Predictors of periodic breathing at altitude [AD-A167947] p 424 N86-32957
**ACTIVE CONTROL**
Active controllers and the time duration to learn a task p 439 N86-32994
**ACTIVITY (BIOLOGY)**
On the interrelationship between different ranges of bioelectric activity of the human brain p 422 A86-49975
**ACTIVITY CYCLES (BIOLOGY)**
The retinal cycle in bacteriorhodopsin --- Russian book p 414 A86-49348
**ADAPTIVE FILTERS**
Implementation of models for the transient division system of spatio-temporal visual perception [ETN-86-97533] p 425 N86-32965
**ADIPOSE TISSUES**
Effect of physical training in humans on the response of isolated fat cells to epinephrine p 418 A86-47868
**AEROSPACE MEDICINE**
Evaluation of 9.5 PSIA as a suit pressure for prolonged extravehicular activity p 417 A86-47741
The relationship of intravascular bubbles to bends at altitude p 418 A86-47765
Ergometric examination of the cardiovascular system in flight personnel p 421 A86-49370
Operational medical planning for Space Station [AIAA PAPER 86-2337] p 421 A86-49560
USSR Space Life Sciences Digest, issue 7 [NASA-CR-3922(08)] p 416 N86-32083
Aerospace medicine and biology: A continuing bibliography with indexes (supplement 288) [NASA-SP-7011(288)] p 422 N86-32088
Air Force technical objective document, Aerospace Medical Division, FY 1987 [AD-A167422] p 423 N86-32090
Special features of surgical intervention under conditions of weightlessness [AD-A167916] p 423 N86-32092
Activities report on physical and psychological health of flying personnel [ETN-86-97385] p 423 N86-32093
Activities report on physical and psychological health of flying personnel [ETN-86-97386] p 423 N86-32094
**AEROSPACE SAFETY**
SAFE Association, Annual Symposium, 23rd, Las Vegas, NV, December 1-5, 1985, Proceedings p 429 A86-47726
Design of a portable, collapsible hyperbaric chamber p 430 A86-47732
Evaluation of 9.5 PSIA as a suit pressure for prolonged extravehicular activity p 417 A86-47741
**AGE FACTOR**
Development of intuitive theories of motion - Curvilinear motion in the absence of external forces p 426 A86-49521
Correlational rhythmography applied to persons of different age under functional loads p 422 A86-49920
**AGING (BIOLOGY)**
Structural correlates of aging in Drosophila - Relevance to the cell differentiation, rate-of-living and free radical theories of aging p 415 A86-49999
**AIR FLOW**
In vivo dermal absorption method and system for laboratory animals [AD-D012325] p 417 N86-32951
**AIR TRAFFIC CONTROLLERS (PERSONNEL)**
Complex monitoring performance and the coronary-prone type A behavior pattern [AD-A168240] p 428 N86-32971
**AIRCRAFT COMPARTMENTS**
Inhalation toxicology. Part 6: Evaluation of the relative toxicity of thermal decomposition products from 9 aircraft panel materials [AD-A168250] p 424 N86-32958
**AIRCRAFT CONTROL**
Application of the method of problem taxonomy to the simulation of human service reliability in the manual steering of aircraft [MBB-LKE-301/S/PUB/216] p 432 A86-47771
A model for the human's use of visual field cues in nap-of-the-Earth flight p 441 N86-33004
A flight test method for pilot/aircraft analysis p 442 N86-33011
**AIRCRAFT EQUIPMENT**
New developments in on board oxygen generators p 430 A86-47740
**AIRCRAFT LANDING**
Determination of the load and stress on a cockpit crew during flight using tasking networks and the SAINT simulation language p 432 A86-47770
Closed-loop, pilot/vehicle analysis of the approach and landing task p 442 N86-33013
**AIRCRAFT PILOTS**
Operator alertness/workload assessment using stochastic model-based analysis of myoelectric signals [AD-A168568] p 429 N86-32974
Automated anthropometric data measurement system [AD-D012299] p 443 N86-33017
**AIRCRAFT SAFETY**
SAFE Association, Annual Symposium, 23rd, Las Vegas, NV, December 1-5, 1985, Proceedings p 429 A86-47726
An engineering test and evaluation of several new anti-G valves --- for high performance fighter aircraft p 430 A86-47734
'The ACDAR' - Advanced chemical defense aircrew respirator p 430 A86-47735
Molecular sieve oxygen generation system (MSOGS) onboard the B-1B bomber p 430 A86-47737
The development of two prototype facial protection systems for high performance aircrew helmets p 430 A86-47739
Tactical Life Support System (TLSS) aircrew integrated garment p 431 A86-47746
The changing face of constant wear anti-exposure protection --- of Naval aircrewmen against immersion hypothermia p 431 A86-47749
A new standard for protective headgear - BS 6658 p 431 A86-47752
**AIRCRAFT STRUCTURES**
Inhalation toxicology. Part 6: Evaluation of the relative toxicity of thermal decomposition products from 9 aircraft panel materials [AD-A168250] p 424 N86-32958
**ALDOSTERONE**
Aldosterone response to angiotensin II during hypoxemia p 418 A86-47870
**ALERTNESS**
Altitude acclimatization (ventilation and chemoresponsiveness) during wakefulness and sleep [AD-A167738] p 423 N86-32091
Complex monitoring performance and the coronary-prone type A behavior pattern [AD-A168240] p 428 N86-32971
Operator alertness/workload assessment using stochastic model-based analysis of myoelectric signals [AD-A168567] p 428 N86-32973
Operator alertness/workload assessment using stochastic model-based analysis of myoelectric signals [AD-A168568] p 429 N86-32974
**ALTITUDE ACCLIMATIZATION**
Altitude acclimatization (ventilation and chemoresponsiveness) during wakefulness and sleep [AD-A167738] p 423 N86-32091
Altitude acclimatization attentuates plasma ammonia during submaximal exercise [AD-A168630] p 425 N86-32962
**ALTITUDE SICKNESS**
Effects of high altitude on neurological and pulmonary function: The effect of high altitude on visual evoked potentials in humans on Mt. Everest [AD-A168335] p 424 N86-32959
Effect of dexamethasone on symptoms of acute mountain sickness at Pikes Peak, Colorado (4300m) [AD-A168662] p 425 N86-32963
**ALTITUDE SIMULATION**
Pulmonary gas exchange in humans exercising at sea level and simulated altitude p 419 A86-47874
**ALTITUDE TOLERANCE**
Nocturnal periodic breathing at altitudes of 6,300 and 8,050 m p 419 A86-47875
**AMMONIA**
Altitude acclimatization attentuates plasma ammonia during submaximal exercise [AD-A168630] p 425 N86-32962
**AMMONIUM COMPOUNDS**
Altitude acclimatization attentuates plasma ammonia during submaximal exercise [AD-A168630] p 425 N86-32962
**ANALOGS**
Development of a mechanical analog of a human spine and viscera p 418 A86-47753
**ANATOMY**
Radiographic determination of mass of inertial tensors of anatomical segments [AD-A168581] p 425 N86-32961

SUBJECT

**ANTHROPOLOGY**
A collation of United States Air Force anthropometry [AD-A168485] p 443 N86-33019
**ANTHROPOMETRY**
Anthropometric considerations for a 4-axis side-arm flight controller p 439 N86-32993
Automated anthropometric data measurement system [AD-D012299] p 443 N86-33017
A collation of United States Air Force anthropometry [AD-A168485] p 443 N86-33019
**ANTICOAGULANTS**
Changes in the blood coagulation system of rabbits under conditions of acute hypoxia and some methods of its correction p 414 A86-49368
**APPROACH CONTROL**
Closed-loop, pilot/vehicle analysis of the approach and landing task p 442 N86-33013
**APTITUDE**
Human factors research in aircrew performance and training [AD-A167740] p 427 N86-32967
**ARMED FORCES (UNITED STATES)**
A collation of United States Air Force anthropometry [AD-A168485] p 443 N86-33019
**ARTIFICIAL INTELLIGENCE**
Use of artificial intelligence and psychology in the analysis of command and control --- military commanders [STC-TM-749] p 427 N86-32095
Artificial intelligence and the Rule Oriented System Simulation (ROSS) language --- military commanders p 427 N86-32097
Knowledge-based load leveling and task allocation in human-machine systems p 437 N86-32985
**ATTENTION**
The effects of stress on attentional resources p 437 N86-32986
**AUDITORY PERCEPTION**
Speech analysis based on a model of the auditory system [AD-A167426] p 427 N86-32098
**AUDITORY STIMULI**
Auditory versus visual selective-attention tasks [IZF-1985-19] p 427 N86-32100
Hesitation in tracking induced by a concurrent manual task p 439 N86-32995
**AUDITORY TASKS**
Auditory versus visual selective-attention tasks [IZF-1985-19] p 427 N86-32100
**AUTOMATIC CONTROL**
Automation and robotics for Space Station in the twenty-first century [AIAA PAPER 86-2300] p 434 A86-49552
**AUTOPSIES**
Special features of surgical intervention under conditions of weightlessness [AD-A167916] p 423 N86-32092

## B

**B-1 AIRCRAFT**
Molecular sieve oxygen generation system (MSOGS) onboard the B-1B bomber p 430 A86-47737
Development of a portable oxygen system analyzer p 430 A86-47742
Test and evaluation of the B-1B molecular sieve oxygen generating system p 431 A86-47751
**BACTERIA**
Halobacterium denitrificans sp. nov. - An extremely halophilic denitrifying bacterium p 414 A86-49524
Photoactive pigments in halobacteria from the Gavish Sabkha p 415 A86-49998
**BACTERIOLOGY**
Proton ejection from bacteriorhodopsin --- Russian book p 413 A86-49346
Proton injection into bacteriorhodopsin --- Russian book p 414 A86-49347
The retinal cycle in bacteriorhodopsin --- Russian book p 414 A86-49348
The rhodopsin-like pigments of halobacteria - Light-energy and signal transducers in an archaebacterium p 415 A86-50271
**BED REST**
Functional state of the pancreas under conditions of prolonged bed rest p 421 A86-49271
**BIBLIOGRAPHIES**
USSR Space Life Sciences Digest, issue 7 [NASA-CR-3922(08)] p 416 N86-32083
Aerospace medicine and biology: A continuing bibliography with indexes (supplement 288) [NASA-SP-7011(288)] p 422 N86-32088
**BIOASTRONAUTICS**
Biochemical responses of Xenopus Laevis muscles to changes in environment. I. - Comparison to Rana Catesbeiana and exposure to gravic environment p 415 A86-50288
USSR Space Life Sciences Digest, issue 7 [NASA-CR-3922(08)] p 416 N86-32083
**BIOCHEMICAL OXYGEN DEMAND**
External respiration, gas exchange, and blood oxygen parameters in acute methemoglobinemia [DRIC-T-7663] p 415 N86-32082
**BIOCHEMISTRY**
Proton injection into bacteriorhodopsin --- Russian book p 414 A86-49347
The retinal cycle in bacteriorhodopsin --- Russian book p 414 A86-49348
Halobacterium denitrificans sp. nov. - An extremely halophilic denitrifying bacterium p 414 A86-49524
The rhodopsin-like pigments of halobacteria - Light-energy and signal transducers in an archaebacterium p 415 A86-50271
Biochemical responses of Xenopus Laevis muscles to changes in environment. I. - Comparison to Rana Catesbeiana and exposure to gravic environment p 415 A86-50288
Biochemical responses of Xenopus laevis muscles to changes in environment. II - Responses to gravity and pressure p 415 A86-50289
Guard cell biochemistry: Response to environmental stimuli causing changes in gas exchange [DE86-010287] p 416 N86-32086
In vivo dermal absorption method and system for laboratory animals [AD-D012325] p 417 N86-32951
**BIOCONTROL SYSTEMS**
Possibility of optimizing respiratory activity by means of biocontrol p 420 A86-49266
**BIODYNAMICS**
Nonlinear mechanisms in physiology and pathophysiology Toward a dynamical theory of health and disease p 422 A86-49636
**BIOELECTRIC POTENTIAL**
Spectral-correlation characteristics of EEG in the course of short-term memory tests. I - A study of spectral-correlation parameters of the potentials in the human neocortex during correct short-term memorizing p 419 A86-49263
Spatial organization of components of the visual evoked potentials and the sensorimotor reaction efficiency p 419 A86-49264
On the interrelationship between different ranges of bioelectric activity of the human brain p 422 A86-49975
**BIOELECTRICITY**
Proton ejection from bacteriorhodopsin --- Russian book p 413 A86-49346
Proton injection into bacteriorhodopsin --- Russian book p 414 A86-49347
The retinal cycle in bacteriorhodopsin --- Russian book p 414 A86-49348
**BIOFEEDBACK**
Possibility of optimizing respiratory activity by means of biocontrol p 420 A86-49266
**BIOINSTRUMENTATION**
Method of high-precision microsampled blood and plasma mass densitometry p 419 A86-49250
**BIOLOGICAL EFFECTS**
Aerospace medicine and biology: A continuing bibliography with indexes (supplement 288) [NASA-SP-7011(288)] p 422 N86-32088
Evaluation of the need for a large primate research facility in space [NASA-CR-179661] p 444 N86-32111
**BIOLOGICAL EVOLUTION**
Development of otoconia in the embryonic chick (Gallus domesticus) p 414 A86-49871
NASA Workshop on Animal Gravity-Sensing Systems [NASA-TM-88249] p 417 N86-32950
**BIOLOGICAL MODELS (MATHEMATICS)**
Dynamics of the cupula in the semicircular canal of the vestibular analyzer --- Russian book p 421 A86-49339
Proton ejection from bacteriorhodopsin --- Russian book p 413 A86-49346
The retinal cycle in bacteriorhodopsin --- Russian book p 414 A86-49348
Implementation of models for the transient division system of spatio-temporal visual perception [ETN-86-97533] p 425 N86-32965
A model of the transient part of the spatio-temporal perception, containing a two-dimensional long fiber [ETN-86-97540] p 426 N86-32966
**BIOMETEOROLOGY**
Seasonal and circadian rhythms in androgen excretion in the extremely continental climate of Trans-Baikal and the BAM region among groups of local nonnative population p 420 A86-49269
**BIOMETRICS**
An analysis of estimation of pulmonary blood flow by the single-breath method p 413 A86-47872
**BIONICS**
The role of impulse parameters in force variability p 439 N86-32997
**BIOPHYSICS**
Dynamics of the cupula in the semicircular canal of the vestibular analyzer --- Russian book p 421 A86-49339
Proton transfer in bacteriorhodopsin --- Russian book p 413 A86-49345
Proton ejection from bacteriorhodopsin --- Russian book p 413 A86-49346
Proton injection into bacteriorhodopsin --- Russian book p 414 A86-49347
The retinal cycle in bacteriorhodopsin --- Russian book p 414 A86-49348
**BIOTECHNOLOGY**
Air Force technical objective document, Aerospace Medical Division, FY 1987 [AD-A167422] p 423 N86-32090
**BIRTH**
Peripheral nerve injury in developing rats reorganizes motor cortex [AD-A168019] p 417 N86-32952
**BLOOD COAGULATION**
Changes in the blood coagulation system of rabbits under conditions of acute hypoxia and some methods of its correction p 414 A86-49368
**BLOOD FLOW**
An analysis of estimation of pulmonary blood flow by the single-breath method p 413 A86-47872
Effect of nerve block on response of forearm blood flow to local temperature p 418 A86-47873
**BLOOD PLASMA**
Method of high-precision microsampled blood and plasma mass densitometry p 419 A86-49250
**BLOOD PRESSURE**
Effect of hydration on some orthostatic and haematological responses to head-up tilt p 419 A86-49225
Complex monitoring performance and the coronary-prone type A behavior pattern [AD-A168240] p 428 N86-32971
**BLOOD VOLUME**
Effect of hydration on some orthostatic and haematological responses to head-up tilt p 419 A86-49225
Fluid and protein shifts after postural changes in humans p 421 A86-49523
**BODY FLUIDS**
Special features of surgical intervention under conditions of weightlessness [AD-A167916] p 423 N86-32092
**BODY SIZE (BIOLOGY)**
A collation of United States Air Force anthropometry [AD-A168485] p 443 N86-33019
**BODY WEIGHT**
Growth and development of rhesus monkeys exposed to ELF (Extremely Low Frequency) electric and magnetic fields during the first 54 months of life [AD-A168733] p 417 N86-32953
**BRAIN**
On the interrelationship between different ranges of bioelectric activity of the human brain p 422 A86-49975
**BRAIN CIRCULATION**
Effect of hypocapnia on ventral medullary blood flow and pH during hypoxia in cats p 413 A86-47869
**BREATHING APPARATUS**
'The ACDAR' - Advanced chemical defense aircrew respirator p 430 A86-47735
Molecular sieve oxygen generation system (MSOGS) onboard the B-1B bomber p 430 A86-47737
**BUBBLES**
The relationship of intravascular bubbles to bends at altitude p 418 A86-47765

## C

**CABIN ATMOSPHERES**
New developments in on board oxygen generators p 430 A86-47740
Development of a portable oxygen system analyzer p 430 A86-47742
**CALIBRATING**
The development and evaluation of color systems for airborne applications: Fundamental visual, perceptual and display systems considerations [AD-A168563] p 443 N86-33020
**CARBON DIOXIDE REMOVAL**
Elementary design guidelines for CO2 scrubbing with LiOH, technical manual [AD-A168850] p 444 N86-33022

**CARDIOLOGY**
Effects of -Gz centrifugal acceleration upon cardiac output of hamster p 415 A86-50290
**CARDIOVASCULAR SYSTEM**
Ergometric examination of the cardiovascular system in flight personnel p 421 A86-49370
**CATHODE RAY TUBES**
Absolute judgment versus absolute magnitude estimation to convey information through symbol magnitude changes in CRT displays
[AD-A167059] p 434 N86-32103
**CAVITIES**
A chinchilla restraint system
[AD-A167408] p 416 N86-32084
**CELL DIVISION**
Structural correlates of aging in Drosophila - Relevance to the cell differentiation, rate-of-living and free radical theories of aging p 415 A86-49999
**CELLS (BIOLOGY)**
Guard cell biochemistry: Response to environmental stimuli causing changes in gas exchange
[DE86-010287] p 416 N86-32086
**CENTRAL NERVOUS SYSTEM STIMULANTS**
The effect of centedrin on the work capacity of operators p 426 A86-49371
**CENTRIFUGING STRESS**
Effects of -Gz centrifugal acceleration upon cardiac output of hamster p 415 A86-50290
**CEREBRAL CORTEX**
Spectral-correlation characteristics of EEG in the course of short-term memory tests. I - A study of spectral-correlation parameters of the potentials in the human neocortex during correct short-term memorizing p 419 A86-49263
Peripheral nerve injury in developing rats reorganizes motor cortex
[AD-A168019] p 417 N86-32952
Analytical comparison of transient and steady state visual evoked cortical potentials p 436 N86-32978
**CEREBRUM**
Peripheral nerve injury in developing rats reorganizes motor cortex
[AD-A168019] p 417 N86-32952
Effects of high altitude on neurological and pulmonary function: The effect of high altitude on visual evoked potentials in humans on Mt. Everest
[AD-A168335] p 424 N86-32959
**CHEMICAL DEFENSE**
'The ACDAR' - Advanced chemical defense aircrew respirator p 430 A86-47735
**CHEMICAL PROPERTIES**
Proposal for a new tomographic device providing information on the chemical properties of a body section
[DE86-010547] p 425 N86-32964
**CHEMICAL WARFARE**
Air Force technical objective document, Aerospace Medical Division, FY 1987
[AD-A167422] p 423 N86-32090
**CHILDREN**
Development of intuitive theories of motion - Curvilinear motion in the absence of external forces p 426 A86-49521
**CHOLINESTERASE**
The activity of cholinesterase and norepinephrine after laser irradiation of acupuncture points p 414 A86-49921
**CHOROID MEMBRANES**
Implementation of models for the transient division system of spatio-temporal visual perception
[ETN-86-97533] p 425 N86-32965
A model of the transient part of the spatio-temporal perception, containing a two-dimensional long fiber
[ETN-86-97540] p 426 N86-32966
**CHROMOSOMES**
The frequency of sister chromatid exchanges in blood cells under prolonged hypokinesia p 421 A86-49272
**CIRCADIAN RHYTHMS**
Seasonal and circadian rhythms in androgen excretion in the extremely continental climate of Trans-Baikal and the BAM region among groups of local nonnative population p 420 A86-49269
A 24-hour structure of vigilance under prolonged sleep deprivation: Relationship with performance
[AD-A167399] p 422 N86-32089
**CLINICAL MEDICINE**
Operational medical planning for Space Station
[AIAA PAPER 86-2337] p 421 A86-49560
**CLOSED CYCLES**
Elementary design guidelines for CO2 scrubbing with LiOH, technical manual
[AD-A168850] p 444 N86-33022
**CLOTTING**
Changes in the blood coagulation system of rabbits under conditions of acute hypoxia and some methods of its correction p 414 A86-49368
**COCKPIT SIMULATORS**
Investigation of pilot behavior within the scope of a training program for handling qualities rating in a ground simulator
[DFVLR-MITT-86-01] p 429 N86-32975
**COCKPITS**
Determination of the load and stress on a cockpit crew during flight using tasking networks and the SAINT simulation language p 432 A86-47770
Night vision compatible illumination for vehicle crewmember workspace
[AD-D012339] p 443 N86-33018
**COGNITION**
Levels of Information Processing in a Fitts law task (LIPFitts) p 436 N86-32980
Evaluation of 2 cognitive abilities tests in a dual-task environment p 438 N86-32988
**COGNITIVE PSYCHOLOGY**
Use of artificial intelligence and psychology in the analysis of command and control --- military commanders
[STC-TM-749] p 427 N86-32095
**COLD ACCLIMATIZATION**
The effect of noradrenaline on oxidation metabolism in cold-adapted golden hamsters p 413 A86-49155
The mechanism of the adaptogenic effect of tocopherol in prolonged cold exposure p 414 A86-49367
**COLD TOLERANCE**
The mechanism of the adaptogenic effect of tocopherol in prolonged cold exposure p 414 A86-49367
**COLD WATER**
The changing face of constant wear anti-exposure protection --- of Naval aircrewmen against immersion hypothermia p 431 A86-47749
**COLOR**
The development and evaluation of color systems for airborne applications: Fundamental visual, perceptual and display systems considerations
[AD-A168563] p 443 N86-33020
**COMBUSTION PRODUCTS**
Inhalation toxicology. Part 6: Evaluation of the relative toxicity of thermal decomposition products from 9 aircraft panel materials
[AD-A168250] p 424 N86-32958
**COMMAND AND CONTROL**
Use of artificial intelligence and psychology in the analysis of command and control --- military commanders
[STC-TM-749] p 427 N86-32095
The psychology of decision making --- military commanders p 427 N86-32096
Artificial intelligence and the Rule Oriented System Simulation (ROSS) language --- military commanders p 427 N86-32097
**COMPENSATORY TRACKING**
Progression-regression effects in tracking repeated patterns p 439 N86-32996
Comparison of the STI NIPIP tracking dynamics identification with the on-line Fourier analyzer DFA results including a time varying case p 442 N86-33010
Maximum normalized acceleration as a flying qualities parameter p 442 N86-33012
**COMPUTATION**
Data collection via a quasi-experimental simulation technology. Part 1: Multiple measurement of performance excellence in complex and uncertain managerial tasks
[AD-A167949] p 428 N86-32969
**COMPUTER GRAPHICS**
Striving for natural usage
[DE86-009402] p 435 N86-32105
**COMPUTER SYSTEMS DESIGN**
Control loops with human operators in space operations. Part 1: Human engineering analysis, synthesis and evaluation techniques
[NLR-TR-84116-L-PT-1] p 435 N86-32107
**COMPUTER TECHNIQUES**
Human problem solving in fault diagnosis tasks
[AD-A167397] p 434 N86-32104
**COMPUTER VISION**
On-orbit manipulators - Sensory and control approaches
[AIAA PAPER 86-2185] p 429 A86-47467
Perspective projection invariants
[AD-A167783] p 428 N86-32968
**COMPUTERIZED SIMULATION**
Determination of the load and stress on a cockpit crew during flight using tasking networks and the SAINT simulation language p 432 A86-47770
Application of the method of problem taxonomy to the simulation of human service reliability in the manual steering of aircraft
[MBB-LKE-301/S/PUB/216] p 432 A86-47771
Flight training for Space Shuttle missions p 427 A86-50283
Human problem solving in fault diagnosis tasks
[AD-A167397] p 434 N86-32104
A simulation study of the effects of sleep deprivation, time of watch and length of time on watch on watchstanding effectiveness
[AD-A167729] p 424 N86-32956
Radiographic determination of mass of inertial tensors of anatomical segments
[AD-A168581] p 425 N86-32961
Data collection via a quasi-experimental simulation technology. Part 1: Multiple measurement of performance excellence in complex and uncertain managerial tasks
[AD-A167949] p 428 N86-32969
**CONFERENCES**
SAFE Association, Annual Symposium, 23rd, Las Vegas, NV, December 1-5, 1985, Proceedings p 429 A86-47726
Evaluation of man-machine systems: Methods and problems; Symposium, November 14, 15, 1985, Cologne, West Germany, Reports
[DGLR-BERICHT 85-04] p 432 A86-47766
**CONSTRAINTS**
A chinchilla restraint system
[AD-A167408] p 416 N86-32084
**CONSTRUCTION**
Inhalation toxicology. Part 6: Evaluation of the relative toxicity of thermal decomposition products from 9 aircraft panel materials
[AD-A168250] p 424 N86-32958
**CONSUMABLES (SPACECREW SUPPLIES)**
NASA Facts: Space Shuttle food systems
[NF-150/1-86] p 434 N86-32102
**CONTAMINATION**
Special features of surgical intervention under conditions of weightlessness
[AD-A167916] p 423 N86-32092
**CONTRAST**
Variable contrast direct read-out vision tester
[AD-D012273] p 423 N86-32955
**CONTROL EQUIPMENT**
User interface description of a gas turbine control system
[ASME PAPER 86-GT-296] p 433 A86-48309
A design guide for visual displays and manual tasks in vibration environments. Part 2: Manual tasks
[ISVR-TR-134] p 443 N86-33015
**CONTROL STICKS**
Flight test of a displacement sidearm controller p 439 N86-32992
Active controllers and the time duration to learn a task p 439 N86-32994
**CONTROL SYSTEMS DESIGN**
Development of a hierarchical multiprocessor control for a polyarticulated mechanical structure used to study human operators subjected to vibrations --- French thesis p 433 A86-48553
Control loops with human operators in space operations. Part 1: Human engineering analysis, synthesis and evaluation techniques
[NLR-TR-84116-L-PT-1] p 435 N86-32107
Control loops with human operators in space operations. Part 4: Research requirements for human-in-the-loop space teleoperator development
[NLR-TR-84116-L-PT-4] p 435 N86-32109
Control loops with human operators in space operations. Part 5: Executive summary
[NLR-TR-84116-L-PT-5] p 435 N86-32110
Flight test of a displacement sidearm controller p 439 N86-32992
Anthropometric considerations for a 4-axis side-arm flight controller p 439 N86-32993
**CONTROL THEORY**
Control theoretic analysis of human operator mediated rendezvous and docking
[NLR-MP-85020-U] p 435 N86-32106
Control loops with human operators in space operations. Part 3: Rendezvous and docking operations and model analysis of performance with human-in-the-loop
[NLR-TR-84116-L-PT-3] p 435 N86-32108
Control loops with human operators in space operations. Part 2: Robotics operations and manual control experiment
[NLR-TR-84116-L-PT-2] p 444 N86-33024
**CONTROL VALVES**
Single stage rapid response anti-G valve p 432 A86-47762
**CONTROLLABILITY**
Investigation of pilot behavior within the scope of a training program for handling qualities rating in a ground simulator
[DFVLR-MITT-86-01] p 429 N86-32975
**CONTROLLED ATMOSPHERES**
Controlled environment life support system: Growth studies with potatoes
[NASA-CR-177400] p 434 N86-32101
**CONTROLLERS**
Control of a free-flying robot manipulator system
[NASA-CR-179717] p 443 N86-33016

**COORDINATION**
Aircrew coordination and decisionmaking: Peer ratings of video tapes made during a full mission simulation p 440 N86-32999
**CORTICOSTEROIDS**
The mechanism of the adaptogenic effect of tocopherol in prolonged cold exposure p 414 A86-49367
**COSMONAUTS**
Special features of surgical intervention under conditions of weightlessness
[AD-A167916] p 423 N86-32092
**CREW PROCEDURES (INFLIGHT)**
Aircrew coordination and decisionmaking: Peer ratings of video tapes made during a full mission simulation p 440 N86-32999
An experimental paradigm for team decision processes p 440 N86-33000
**CREW STATIONS**
The development and evaluation of color systems for airborne applications: Fundamental visual, perceptual and display systems considerations
[AD-A168563] p 443 N86-33020
**CYTOLOGY**
Effect of physical training in humans on the response of isolated fat cells to epinephrine p 418 A86-47868
The frequency of sister chromatid exchanges in blood cells under prolonged hypokinesia p 421 A86-49272
Structural correlates of aging in Drosophila - Relevance to the cell differentiation, rate-of-living and free radical theories of aging p 415 A86-49999

## D

**DATA ACQUISITION**
Data collection via a quasi-experimental simulation technology. Part 1: Multiple measurement of performance excellence in complex and uncertain managerial tasks
[AD-A167949] p 428 N86-32969
**DATA PROCESSING**
Levels of Information Processing in a Fitts law task (LIPFitts) p 436 N86-32980
**DATA SYSTEMS**
Automated anthropometric data measurement system
[AD-D012299] p 443 N86-33017
**DATA TRANSMISSION**
Absolute judgment versus absolute magnitude estimation to convey information through symbol magnitude changes in CRT displays
[AD-A167059] p 434 N86-32103
Automated anthropometric data measurement system
[AD-D012299] p 443 N86-33017
**DECISION MAKING**
The psychology of decision making --- military commanders p 427 N86-32096
Artificial intelligence and the Rule Oriented System Simulation (ROSS) language --- military commanders p 427 N86-32097
Human problem solving in fault diagnosis tasks
[AD-A167397] p 434 N86-32104
Data collection via a quasi-experimental simulation technology. Part 1: Multiple measurement of performance excellence in complex and uncertain managerial tasks
[AD-A167949] p 428 N86-32969
Twenty-First Annual Conference on Manual Control
[NASA-CP-2428] p 436 N86-32976
Aircrew coordination and decisionmaking: Peer ratings of video tapes made during a full mission simulation p 440 N86-32999
An experimental paradigm for team decision processes p 440 N86-33000
Investigation of crew performance in a multi-vehicle supervisory control task p 440 N86-33001
**DECISION THEORY**
The psychology of decision making --- military commanders p 427 N86-32096
**DECOMPRESSION SICKNESS**
Design of a portable, collapsible hyperbaric chamber p 430 A86-47732
Evaluation of 9.5 PSIA as a suit pressure for prolonged extravehicular activity p 417 A86-47741
The relationship of intravascular bubbles to bends at altitude p 418 A86-47765
**DEMOGRAPHY**
Automated anthropometric data measurement system
[AD-D012299] p 443 N86-33017
A collation of United States Air Force anthropometry
[AD-A168485] p 443 N86-33019
**DENITROGENATION**
Halobacterium denitrificans sp. nov. - An extremely halophilic denitrifying bacterium p 414 A86-49524
**DENSITOMETERS**
Method of high-precision microsampled blood and plasma mass densitometry p 419 A86-49250
**DESIGN ANALYSIS**
Design for a goal-oriented telerobotic system
[AIAA PAPER 86-2090] p 429 A86-47440
Improved flexibility of an EVA glove p 433 A86-48713
**DIGESTIVE SYSTEM**
Influence of gravity on structure and behavior of Paramecium caudatum
[ESA-TT-963] p 416 N86-32087
**DISPLAY DEVICES**
Absolute judgment versus absolute magnitude estimation to convey information through symbol magnitude changes in CRT displays
[AD-A167059] p 434 N86-32103
Variable contrast direct read-out vision tester
[AD-D012273] p 423 N86-32955
Force/torque display for space teleoperation control experiments and evaluation p 440 N86-33002
Model analysis of remotely controlled rendezvous and docking with display prediction p 441 N86-33003
Optimal cooperative control synthesis of active displays p 441 N86-33006
The development and evaluation of color systems for airborne applications: Fundamental visual, perceptual and display systems considerations
[AD-A168563] p 443 N86-33020
**DIURNAL VARIATIONS**
Nocturnal periodic breathing at altitudes of 6,300 and 8,050 m p 419 A86-47875
**DIVING (UNDERWATER)**
Elementary design guidelines for CO2 scrubbing with LiOH, technical manual
[AD-A168850] p 444 N86-33022
**DRUGS**
Changes in the blood coagulation system of rabbits under conditions of acute hypoxia and some methods of its correction p 414 A86-49368
Effects of high altitude on neurological and pulmonary function: The effect of high altitude on visual evoked potentials in humans on Mt. Everest
[AD-A168335] p 424 N86-32959
Effect of dexamethasone on symptoms of acute mountain sickness at Pikes Peak, Colorado (4300m)
[AD-A168662] p 425 N86-32963
**DUMMIES**
Development of a mechanical analog of a human spine and viscera p 418 A86-47753
A comparison of the specific absorption rate in a homogeneous man model and a man model containing realistic model bones
[AD-A168547] p 424 N86-32960
**DYNAMIC RESPONSE**
Investigation of limb-sidestick dynamic interaction with roll control p 438 N86-32991

## E

**EDEMA**
Effects of high altitude on neurological and pulmonary function: The effect of high altitude on visual evoked potentials in humans on Mt. Everest
[AD-A168335] p 424 N86-32959
**EDUCATION**
The startle reflex as a learning task: Apparatus and test parameters
[AD-A167958] p 428 N86-32970
**EFFERENT NERVOUS SYSTEMS**
Peripheral nerve injury in developing rats reorganizes motor cortex
[AD-A168019] p 417 N86-32952
**EJECTION SEATS**
Development of a mechanical analog of a human spine and viscera p 418 A86-47753
**ELECTRIC FIELDS**
Growth and development of rhesus monkeys exposed to ELF (Extremely Low Frequency) electric and magnetic fields during the first 54 months of life
[AD-A168733] p 417 N86-32953
**ELECTROENCEPHALOGRAPHY**
Spectral-correlation characteristics of EEG in the course of short-term memory tests. I - A study of spectral-correlation parameters of the potentials in the human neocortex during correct short-term memorizing p 419 A86-49263
Spatial organization of components of the visual evoked potentials and the sensorimotor reaction efficiency p 419 A86-49264
EEG correlates in the process of forming driving skills p 421 A86-49273
On the interrelationship between different ranges of bioelectric activity of the human brain p 422 A86-49975
Effects of high altitude on neurological and pulmonary function: The effect of high altitude on visual evoked potentials in humans on Mt. Everest
[AD-A168335] p 424 N86-32959
**ELECTROLUMINESCENCE**
Variable contrast direct read-out vision tester
[AD-D012273] p 423 N86-32955
**ELECTROMYOGRAPHY**
Operator alertness/workload assessment using stochastic model-based analysis of myoelectric signals
[AD-A168567] p 428 N86-32973
Operator alertness/workload assessment using stochastic model-based analysis of myoelectric signals
[AD-A168568] p 429 N86-32974
**ELECTROPHYSIOLOGY**
Peripheral nerve injury in developing rats reorganizes motor cortex
[AD-A168019] p 417 N86-32952
**EMBRYOLOGY**
Development of otoconia in the embryonic chick (Gallus domesticus) p 414 A86-49871
**EMBRYOS**
Development of otoconia in the embryonic chick (Gallus domesticus) p 414 A86-49871
**EMOTIONAL FACTORS**
Effects of hypodynamia and neuroemotional stress on the performance of circulatory and respiratory systems during muscular work p 422 A86-49919
**ENDOCRINOLOGY**
Functional state of the pancreas under conditions of prolonged bed rest p 421 A86-49271
**ENERGY ABSORPTION**
A comparison of the specific absorption rate in a homogeneous man model and a man model containing realistic model bones
[AD-A168547] p 424 N86-32960
**ENGINE CONTROL**
User interface description of a gas turbine control system
[ASME PAPER 86-GT-296] p 433 A86-48309
**ENVIRONMENTAL CONTROL**
Controlled environment life support system: Growth studies with potatoes
[NASA-CR-177400] p 434 N86-32101
**ENVIRONMENTS**
Guard cell biochemistry: Response to environmental stimuli causing changes in gas exchange
[DE86-010287] p 416 N86-32086
A design guide for visual displays and manual tasks in vibration environments. Part 2: Manual tasks
[ISVR-TR-134] p 443 N86-33015
Elementary design guidelines for CO2 scrubbing with LiOH, technical manual
[AD-A168850] p 444 N86-33022
**ENZYME ACTIVITY**
The activity of cholinesterase and norepinephrine after laser irradiation of acupuncture points p 414 A86-49921
Gas exchange characteristics of leaves as indicators of the basic limitations to the rate of photosynthesis
[DE86-009632] p 416 N86-32085
**EPINEPHRINE**
Effect of physical training in humans on the response of isolated fat cells to epinephrine p 418 A86-47868
**ERGOMETERS**
Ergometric examination of the cardiovascular system in flight personnel p 421 A86-49370
**ERRORS**
Progression-regression effects in tracking repeated patterns p 439 N86-32996
A design guide for visual displays and manual tasks in vibration environments. Part 1: Visual displays
[ISVR-TR-133-PT-1] p 442 N86-33014
**EUROPEAN SPACE AGENCY**
Control loops with human operators in space operations. Part 4: Research requirements for human-in-the-loop space teleoperator development
[NLR-TR-84116-L-PT-4] p 435 N86-32109
**EVOKED RESPONSE (PSYCHOPHYSIOLOGY)**
Spatial organization of components of the visual evoked potentials and the sensorimotor reaction efficiency p 419 A86-49264
Effects of high altitude on neurological and pulmonary function: The effect of high altitude on visual evoked potentials in humans on Mt. Everest
[AD-A168335] p 424 N86-32959
Descriptive Linear modeling of steady-state visual evoked response p 436 N86-32977
Analytical comparison of transient and steady state visual evoked cortical potentials p 436 N86-32978
**EXERCISE PHYSIOLOGY**
Effect of physical training in humans on the response of isolated fat cells to epinephrine p 418 A86-47868
Aldosterone response to angiotensin II during hypoxemia p 418 A86-47870

Pulmonary gas exchange in humans exercising at sea level and simulated altitude p 419 A86-47874
**EXOBIOLOGY**
USSR Space Life Sciences Digest, issue 7 [NASA-CR-3922(08)] p 416 N86-32083
**EXPERT SYSTEMS**
Design for a goal-oriented telerobotic system [AIAA PAPER 86-2090] p 429 A86-47440
Aiding the operator during novel fault diagnosis p 426 A86-49633
**EXPONENTIAL FUNCTIONS**
Speech analysis based on a model of the auditory system [AD-A167426] p 427 N86-32098
**EXTRAVEHICULAR ACTIVITY**
Design of a portable, collapsible hyperbaric chamber p 430 A86-47732
Evaluation of 9.5 PSIA as a suit pressure for prolonged extravehicular activity p 417 A86-47741
Improved flexibility of an EVA glove p 433 A86-48713
**EXTREMELY LOW FREQUENCIES**
Growth and development of rhesus monkeys exposed to ELF (Extremely Low Frequency) electric and magnetic fields during the first 54 months of life [AD-A168733] p 417 N86-32953

## F

**FAILURE ANALYSIS**
Aiding the operator during novel fault diagnosis p 426 A86-49633
**FAR FIELDS**
A comparison of the specific absorption rate in a homogeneous man model and a man model containing realistic model bones [AD-A168547] p 424 N86-32960
**FEEDBACK CONTROL**
Modified superposition: A simple time series approach to closed-loop manual controller identification p 442 N86-33009
A flight test method for pilot/aircraft analysis p 442 N86-33011
Closed-loop, pilot/vehicle analysis of the approach and landing task p 442 N86-33013
**FIGHTER AIRCRAFT**
An engineering test and evaluation of several new anti-G valves --- for high performance fighter aircraft p 430 A86-47734
Current research on advanced concept anti-G suits p 431 A86-47747
Single stage rapid response anti-G valve p 432 A86-47762
**FLAMMABLE GASES**
Inhalation toxicology. Part 6: Evaluation of the relative toxicity of thermal decomposition products from 9 aircraft panel materials [AD-A168250] p 424 N86-32958
**FLEXIBLE SPACECRAFT**
On-orbit manipulators - Sensory and control approaches [AIAA PAPER 86-2185] p 429 A86-47467
**FLIGHT CHARACTERISTICS**
Maximum normalized acceleration as a flying qualities parameter p 442 N86-33012
**FLIGHT CONTROL**
Flight test of a displacement sidearm controller p 439 N86-32992
Anthropometric considerations for a 4-axis side-arm flight controller p 439 N86-32993
A flight test method for pilot/aircraft analysis p 442 N86-33011
The development and evaluation of color systems for airborne applications: Fundamental visual, perceptual and display systems considerations [AD-A168563] p 443 N86-33020
**FLIGHT CREWS**
'The ACDAR' - Advanced chemical defense aircrew respirator p 430 A86-47735
The development of two prototype facial protection systems for high performance aircrew helmets p 430 A86-47739
Tactical Life Support System (TLSS) aircrew integrated garment p 431 A86-47746
The changing face of constant wear anti-exposure protection --- of Naval aircrewmen against immersion hypothermia p 431 A86-47749
Determination of the load and stress on a cockpit crew during flight using tasking networks and the SAINT simulation language p 432 A86-47770
Human factors research in aircrew performance and training [AD-A167740] p 427 N86-32967
An experimental paradigm for team decision processes p 440 N86-33000
Investigation of crew performance in a multi-vehicle supervisory control task p 440 N86-33001
**FLIGHT FITNESS**
Ergometric examination of the cardiovascular system in flight personnel p 421 A86-49370
**FLIGHT SIMULATORS**
A comparison of postural equilibrium effects following exposure to different ground-based flight trainers p 418 A86-47754
**FLIGHT TESTS**
Human factors research in aircrew performance and training [AD-A167740] p 427 N86-32967
Flight test of a displacement sidearm controller p 439 N86-32992
A flight test method for pilot/aircraft analysis p 442 N86-33011
**FLIGHT TRAINING**
Human factors research in aircrew performance and training [AD-A167740] p 427 N86-32967
Multitask performance: Predicting success in Naval Aviation primary flight training [AD-A168246] p 428 N86-32972
**FLUX DENSITY**
Inhalation toxicology. Part 6: Evaluation of the relative toxicity of thermal decomposition products from 9 aircraft panel materials [AD-A168250] p 424 N86-32958
**FLY BY WIRE CONTROL**
Pilot interface with fly by wire control systems p 438 N86-32990
**FOURIER TRANSFORMATION**
Analytical comparison of transient and steady state visual evoked cortical potentials p 436 N86-32978
Comparison of the STI NIPIP tracking dynamics identification with the on-line Fourier analyzer DFA results including a time varying case p 442 N86-33010
**FREE RADICALS**
Structural correlates of aging in Drosophila - Relevance to the cell differentiation, rate-of-living and free radical theories of aging p 415 A86-49999

## G

**GAS EXCHANGE**
Pulmonary gas exchange in humans exercising at sea level and simulated altitude p 419 A86-47874
Gas exchange characteristics of leaves as indicators of the basic limitations to the rate of photosynthesis [DE86-009632] p 416 N86-32085
Guard cell biochemistry: Response to environmental stimuli causing changes in gas exchange [DE86-010287] p 416 N86-32086
**GAS TURBINE ENGINES**
User interface description of a gas turbine control system [ASME PAPER 86-GT-296] p 433 A86-48309
**GEOMETRIC ACCURACY**
Virtual space and 2-dimensional effects in perspective displays p 441 N86-33005
**GEOTROPISM**
Influence of gravity on structure and behavior of Paramecium caudatum [ESA-TT-963] p 416 N86-32087
**GERONTOLOGY**
Structural correlates of aging in Drosophila - Relevance to the cell differentiation, rate-of-living and free radical theories of aging p 415 A86-49999
**GLUCOSE**
Altitude acclimatization attentuates plasma ammonia during submaximal exercise [AD-A168630] p 425 N86-32962
**GRAVIRECEPTORS**
NASA Workshop on Animal Gravity-Sensing Systems [NASA-TM-88249] p 417 N86-32950
**GRAVITATIONAL EFFECTS**
Influence of gravity on structure and behavior of Paramecium caudatum [ESA-TT-963] p 416 N86-32087
NASA Workshop on Animal Gravity-Sensing Systems [NASA-TM-88249] p 417 N86-32950
**GRAVITATIONAL PHYSIOLOGY**
The frequency of sister chromatid exchanges in blood cells under prolonged hypokinesia p 421 A86-49272
Dynamics of the cupula in the semicircular canal of the vestibular analyzer --- Russian book p 421 A86-49339
Development of otoconia in the embryonic chick (Gallus domesticus) p 414 A86-49871
Biochemical responses of Xenopus Laevis muscles to changes in environment. I. - Comparison to Rana Catesbeiana and exposure to gravic environment p 415 A86-50288
Biochemical responses of Xenopus laevis muscles to changes in environment. II - Responses to gravity and pressure p 415 A86-50289
Effects of -Gz centrifugal acceleration upon cardiac output of hamster p 415 A86-50290
**GROUP DYNAMICS**
An experimental paradigm for team decision processes p 440 N86-33000
**GROWTH**
Controlled environment life support system: Growth studies with potatoes [NASA-CR-177400] p 434 N86-32101
Growth and development of rhesus monkeys exposed to ELF (Extremely Low Frequency) electric and magnetic fields during the first 54 months of life [AD-A168733] p 417 N86-32953

## H

**HALOPHILES**
Halobacterium denitrificans sp. nov. - An extremely halophilic denitrifying bacterium p 414 A86-49524
The rhodopsin-like pigments of halobacteria - Light-energy and signal transducers in an archaebacterium p 415 A86-50271
**HEAD MOVEMENT**
Effect of hydration on some orthostatic and haematological responses to head-up tilt p 419 A86-49225
**HEADACHE**
Effects of high altitude on neurological and pulmonary function: The effect of high altitude on visual evoked potentials in humans on Mt. Everest [AD-A168335] p 424 N86-32959
**HEALTH PHYSICS**
The use of a constitutional approach in the evaluation of health status p 420 A86-49270
**HEARING**
A chinchilla restraint system [AD-A167408] p 416 N86-32084
Speech analysis based on a model of the auditory system [AD-A167426] p 427 N86-32098
**HEART FUNCTION**
Effects of -Gz centrifugal acceleration upon cardiac output of hamster p 415 A86-50290
**HEART RATE**
The use of cardiac-rhythm statistical characteristics in evaluating mental work capacity p 420 A86-49265
Complex monitoring performance and the coronary-prone type A behavior pattern [AD-A168240] p 428 N86-32971
**HELICOPTER CONTROL**
Anthropometric considerations for a 4-axis side-arm flight controller p 439 N86-32993
**HELICOPTERS**
A model of the human's use of visual field cues in nap-of-the-earth flight [AIAA PAPER 86-2252] p 426 A86-47498
Improvements and modifications to naval helicopter helmets p 431 A86-47761
Human factors research in aircrew performance and training [AD-A167740] p 427 N86-32967
**HELMETS**
The development of two prototype facial protection systems for high performance aircrew helmets p 430 A86-47739
A new standard for protective headgear - BS 6658 p 431 A86-47752
Improvements and modifications to naval helicopter helmets p 431 A86-47761
**HEMATOLOGY**
The frequency of sister chromatid exchanges in blood cells under prolonged hypokinesia p 421 A86-49272
**HEMODYNAMIC RESPONSES**
Effect of nerve block on response of forearm blood flow to local temperature p 418 A86-47873
Fluid and protein shifts after postural changes in humans p 421 A86-49523
**HIERARCHIES**
Development of a hierarchical multiprocessor control for a polyarticulated mechanical structure used to study human operators subjected to vibrations --- French thesis p 433 A86-48553
**HIGH ALTITUDE BREATHING**
Altitude acclimatization (ventilation and chemoresponsiveness) during wakefulness and sleep [AD-A167738] p 423 N86-32091
**HORMONE METABOLISMS**
Seasonal and circadian rhythms in androgen excretion in the extremely continental climate of Trans-Baikal and the BAM region among groups of local nonnative population p 420 A86-49269

**HUMAN BEHAVIOR**
Issues in rule identification and logical induction p 434 A86-49634
The startle reflex as a learning task: Apparatus and test parameters
[AD-A167958] p 428 N86-32970
The effects of stress on attentional resources p 437 N86-32986
**HUMAN BEINGS**
Effects of high altitude on neurological and pulmonary function: The effect of high altitude on visual evoked potentials in humans on Mt. Everest
[AD-A168335] p 424 N86-32959
Altitude acclimatization attentuates plasma ammonia during submaximal exercise
[AD-A168630] p 425 N86-32962
**HUMAN BODY**
A comparison of the specific absorption rate in a homogeneous man model and a man model containing realistic model bones
[AD-A168547] p 424 N86-32960
Radiographic determination of mass of inertial tensors of anatomical segments
[AD-A168581] p 425 N86-32961
Proposal for a new tomographic device providing information on the chemical properties of a body section
[DE86-010547] p 425 N86-32964
**HUMAN CENTRIFUGES**
Activities report on physical and psychological health of flying personnel
[ETN-86-97385] p 423 N86-32093
Activities report on physical and psychological health of flying personnel
[ETN-86-97386] p 423 N86-32094
**HUMAN FACTORS ENGINEERING**
Evaluation of man-machine systems: Methods and problems; Symposium, November 14, 15, 1985, Cologne, West Germany, Reports
[DGLR-BERICHT 85-04] p 432 A86-47766
User interface description of a gas turbine control system
[ASME PAPER 86-GT-296] p 433 A86-48309
Development of a hierarchical multiprocessor control for a polyarticulated mechanical structure used to study human operators subjected to vibrations --- French thesis p 433 A86-48553
Striving for natural usage
[DE86-009402] p 435 N86-32105
Control loops with human operators in space operations. Part 1: Human engineering analysis, synthesis and evaluation techniques
[NLR-TR-84116-L-PT-1] p 435 N86-32107
Control loops with human operators in space operations. Part 4: Research requirements for human-in-the-loop space teleoperator development
[NLR-TR-84116-L-PT-4] p 435 N86-32109
Control loops with human operators in space operations. Part 5: Executive summary
[NLR-TR-84116-L-PT-5] p 435 N86-32110
Human factors research in aircrew performance and training
[AD-A167740] p 427 N86-32967
Twenty-First Annual Conference on Manual Control
[NASA-CP-2428] p 436 N86-32976
The development and evaluation of color systems for airborne applications: Fundamental visual, perceptual and display systems considerations
[AD-A168563] p 443 N86-33020
Human Factors Review Plan
[DE86-010561] p 444 N86-33023
Control loops with human operators in space operations. Part 2: Robotics operations and manual control experiment
[NLR-TR-84116-L-PT-2] p 444 N86-33024
**HUMAN PERFORMANCE**
Artificial intelligence and the Rule Oriented System Simulation (ROSS) language --- military commanders p 427 N86-32097
Auditory versus visual selective-attention tasks
[IZF-1985-19] p 427 N86-32100
Human problem solving in fault diagnosis tasks
[AD-A167397] p 434 N86-32104
A simulation study of the effects of sleep deprivation, time of watch and length of time on watch on watchstanding effectiveness
[AD-A167729] p 424 N86-32956
Human factors research in aircrew performance and training
[AD-A167740] p 427 N86-32967
Complex monitoring performance and the coronary-prone type A behavior pattern
[AD-A168240] p 428 N86-32971
Twenty-First Annual Conference on Manual Control
[NASA-CP-2428] p 436 N86-32976
Analytical comparison of transient and steady state visual evoked cortical potentials p 436 N86-32978
The effects of acceleration stress on human workload and manual control p 437 N86-32984
At least some errors are randomly generated (Freud was wrong) p 438 N86-32989
Hitts Law? A test of the relationship between information load and movement precision p 440 N86-32998
Some computational techniques for estimating human operator describing functions p 441 N86-33007
Manual control of unstable systems p 441 N86-33008
A design guide for visual displays and manual tasks in vibration environments. Part 1: Visual displays
[ISVR-TR-133-PT-1] p 442 N86-33014
A design guide for visual displays and manual tasks in vibration environments. Part 2: Manual tasks
[ISVR-TR-134] p 443 N86-33015
**HUMAN REACTIONS**
A comparison of postural equilibrium effects following exposure to different ground-based flight trainers p 418 A86-47754
The effects of stimulus modality and task integrality: Predicting dual-task performance and workload from single-task levels p 436 N86-32981
**HYDRATION**
Effect of hydration on some orthostatic and haematological responses to head-up tilt p 419 A86-49225
**HYDROXIDES**
Elementary design guidelines for CO2 scrubbing with LiOH, technical manual
[AD-A168850] p 444 N86-33022
**HYGIENE**
NASA Facts: Space Shuttle food systems
[NF-150/1-86] p 434 N86-32102
**HYPERBARIC CHAMBERS**
Design of a portable, collapsible hyperbaric chamber p 430 A86-47732
**HYPERCAPNIA**
Altitude acclimatization (ventilation and chemoresponsiveness) during wakefulness and sleep
[AD-A167738] p 423 N86-32091
Predictors of periodic breathing at altitude
[AD-A167947] p 424 N86-32957
**HYPERVENTILATION**
Predictors of periodic breathing at altitude
[AD-A167947] p 424 N86-32957
Effect of oxygen flow on passenger face mask performance
[AD-A168832] p 443 N86-33021
**HYPNOSIS**
Zopiclone's residual effect upon actual driving performance versus those of nitrazepam and flunitrazepam
[VK-84-10] p 423 N86-32954
**HYPOCAPNIA**
Effect of hypocapnia on ventral medullary blood flow and pH during hypoxia in cats p 413 A86-47869
Possibility of optimizing respiratory activity by means of biocontrol p 420 A86-49266
**HYPODYNAMIA**
Effects of hypodynamia and neuroemotional stress on the performance of circulatory and respiratory systems during muscular work p 422 A86-49919
**HYPOKINESIA**
Effect of inactivity and passive stretch on protein turnover in phasic and postural rat muscles p 413 A86-47871
Functional state of the pancreas under conditions of prolonged bed rest p 421 A86-49271
The frequency of sister chromatid exchanges in blood cells under prolonged hypokinesia p 421 A86-49272
**HYPOTHERMIA**
The changing face of constant wear anti-exposure protection --- of Naval aircrewmen against immersion hypothermia p 431 A86-47749
Effect of nerve block on response of forearm blood flow to local temperature p 418 A86-47873
**HYPOXEMIA**
Aldosterone response to angiotensin II during hypoxemia p 418 A86-47870
External respiration, gas exchange, and blood oxygen parameters in acute methemoglobinemia
[DRIC-T-7663] p 415 N86-32082
**HYPOXIA**
Effect of hypocapnia on ventral medullary blood flow and pH during hypoxia in cats p 413 A86-47869
Changes in the blood coagulation system of rabbits under conditions of acute hypoxia and some methods of its correction p 414 A86-49368
External respiration, gas exchange, and blood oxygen parameters in acute methemoglobinemia
[DRIC-T-7663] p 415 N86-32082
Altitude acclimatization (ventilation and chemoresponsiveness) during wakefulness and sleep
[AD-A167738] p 423 N86-32091
Effect of oxygen flow on passenger face mask performance
[AD-A168832] p 443 N86-33021

## I

**ILLUMINATING**
Night vision compatible illumination for vehicle crewmember workspace
[AD-D012339] p 443 N86-33018
**IMAGE PROCESSING**
Striving for natural usage
[DE86-009402] p 435 N86-32105
**IMAGES**
Perspective projection invariants
[AD-A167783] p 428 N86-32968
**IMMUNOLOGY**
Changes in immunity under stress p 420 A86-49267
**IMPULSES**
The role of impulse parameters in force variability p 439 N86-32997
**INFORMATION THEORY**
Auditory versus visual selective-attention tasks
[IZF-1985-19] p 427 N86-32100
Absolute judgment versus absolute magnitude estimation to convey information through symbol magnitude changes in CRT displays
[AD-A167059] p 434 N86-32103
**INJURIES**
Peripheral nerve injury in developing rats reorganizes motor cortex
[AD-A168019] p 417 N86-32952
**INSOMNIA**
Zopiclone's residual effect upon actual driving performance versus those of nitrazepam and flunitrazepam
[VK-84-10] p 423 N86-32954
**INSULIN**
Altitude acclimatization attentuates plasma ammonia during submaximal exercise
[AD-A168630] p 425 N86-32962
**INTERNAL PRESSURE**
Improved flexibility of an EVA glove p 433 A86-48713
**INTESTINES**
Special features of surgical intervention under conditions of weightlessness
[AD-A167916] p 423 N86-32092
**IRRADIATION**
A comparison of the specific absorption rate in a homogeneous man model and a man model containing realistic model bones
[AD-A168547] p 424 N86-32960

## L

**LACTATES**
Altitude acclimatization attentuates plasma ammonia during submaximal exercise
[AD-A168630] p 425 N86-32962
**LANGUAGES**
Issues in rule identification and logical induction p 434 A86-49634
**LASER APPLICATIONS**
The activity of cholinesterase and norepinephrine after laser irradiation of acupuncture points p 414 A86-49921
**LATERAL CONTROL**
Investigation of limb-sidestick dynamic interaction with roll control p 438 N86-32991
**LEADERSHIP**
Use of artificial intelligence and psychology in the analysis of command and control --- military commanders
[STC-TM-749] p 427 N86-32095
The psychology of decision making --- military commanders p 427 N86-32096
**LEARNING**
EEG correlates in the process of forming driving skills p 421 A86-49273
Active controllers and the time duration to learn a task p 439 N86-32994
Progression-regression effects in tracking repeated patterns p 439 N86-32996
**LEARNING CURVES**
The startle reflex as a learning task: Apparatus and test parameters
[AD-A167958] p 428 N86-32970
**LEAST SQUARES METHOD**
Comparison of the STI NIPIP tracking dynamics identification with the on-line Fourier analyzer DFA results including a time varying case p 442 N86-33010

**LEAVES**
Gas exchange characteristics of leaves as indicators of the basic limitations to the rate of photosynthesis
[DE86-009632] p 416 N86-32085
**LIFE SUPPORT SYSTEMS**
Tactical Life Support System (TLSS) aircrew integrated garment p 431 A86-47746
Air Force technical objective document, Aerospace Medical Division, FY 1987
[AD-A167422] p 423 N86-32090
Controlled environment life support system: Growth studies with potatoes
[NASA-CR-177400] p 434 N86-32101
Elementary design guidelines for CO2 scrubbing with LiOH, technical manual
[AD-A168850] p 444 N86-33022
**LIGHT ADAPTATION**
The rhodopsin-like pigments of halobacteria - Light-energy and signal transducers in an archaebacterium p 415 A86-50271
**LIGHT EMITTING DIODES**
Visibility threshold range observations of LED emergency egress lighting strips and signs through dense smoke and turbid water p 417 A86-47729
Night vision compatible illumination for vehicle crewmember workspace
[AD-D012339] p 443 N86-33018
**LIGHTING EQUIPMENT**
Night vision compatible illumination for vehicle crewmember workspace
[AD-D012339] p 443 N86-33018
The development and evaluation of color systems for airborne applications: Fundamental visual, perceptual and display systems considerations
[AD-A168563] p 443 N86-33020
**LINEAR EQUATIONS**
Descriptive Linear modeling of steady-state visual evoked response p 436 N86-32977
**LITHIUM COMPOUNDS**
Elementary design guidelines for CO2 scrubbing with LiOH, technical manual
[AD-A168850] p 444 N86-33022
**LOGICAL ELEMENTS**
Issues in rule identification and logical induction p 434 A86-49634
**LONG DURATION SPACE FLIGHT**
Evaluation of the need for a large primate research facility in space
[NASA-CR-179661] p 444 N86-32111
**LOW VISIBILITY**
Visibility threshold range observations of LED emergency egress lighting strips and signs through dense smoke and turbid water p 417 A86-47729

# M

**MAGNETIC FIELDS**
Growth and development of rhesus monkeys exposed to ELF (Extremely Low Frequency) electric and magnetic fields during the first 54 months of life
[AD-A168733] p 417 N86-32953
**MAN MACHINE SYSTEMS**
Evaluation of man-machine systems: Methods and problems; Symposium, November 14, 15, 1985, Cologne, West Germany, Reports
[DGLR-BERICHT 85-04] p 432 A86-47766
Evaluation of man-machine systems - Introduction and overview p 432 A86-47767
Investigating the ocular fixation of targets as an anthropotechnical research method in man-machine systems p 433 A86-47772
A basic concept for evaluating man-machine systems p 433 A86-47773
Techniques of asking questions in the evaluation of man-machine systems p 433 A86-47774
A measure of usability --- of man-machine systems p 433 A86-47775
User interface description of a gas turbine control system
[ASME PAPER 86-GT-296] p 433 A86-48309
Aiding the operator during novel fault diagnosis p 426 A86-49633
Issues in rule identification and logical induction p 434 A86-49634
Control theoretic analysis of human operator mediated rendezvous and docking
[NLR-MP-85020-U] p 435 N86-32106
Control loops with human operators in space operations. Part 1: Human engineering analysis, synthesis and evaluation techniques
[NLR-TR-84116-L-PT-1] p 435 N86-32107
Control loops with human operators in space operations. Part 3: Rendezvous and docking operations and model analysis of performance with human-in-the-loop
[NLR-TR-84116-L-PT-3] p 435 N86-32108
Control loops with human operators in space operations. Part 4: Research requirements for human-in-the-loop space teleoperator development
[NLR-TR-84116-L-PT-4] p 435 N86-32109
Control loops with human operators in space operations. Part 5: Executive summary
[NLR-TR-84116-L-PT-5] p 435 N86-32110
Twenty-First Annual Conference on Manual Control
[NASA-CP-2428] p 436 N86-32976
Knowledge-based load leveling and task allocation in human-machine systems p 437 N86-32985
At least some errors are randomly generated (Freud was wrong) p 438 N86-32989
Pilot interface with fly by wire control systems p 438 N86-32990
Control loops with human operators in space operations. Part 2: Robotics operations and manual control experiment
[NLR-TR-84116-L-PT-2] p 444 N86-33024
**MAN-COMPUTER INTERFACE**
Aiding the operator during novel fault diagnosis p 426 A86-49633
Hitts Law? A test of the relationship between information load and movement precision p 440 N86-32998
**MANIPULATORS**
On-orbit manipulators - Sensory and control approaches
[AIAA PAPER 86-2185] p 429 A86-47467
Control of a free-flying robot manipulator system
[NASA-CR-179717] p 443 N86-33016
**MANNED SPACECRAFT**
Design for a goal-oriented telerobotic system
[AIAA PAPER 86-2090] p 429 A86-47440
**MANUAL CONTROL**
Twenty-First Annual Conference on Manual Control
[NASA-CP-2428] p 436 N86-32976
The effects of acceleration stress on human workload and manual control p 437 N86-32984
The effects of voice and manual control mode on dual task performance p 438 N86-32987
Pilot interface with fly by wire control systems p 438 N86-32990
Flight test of a displacement sidearm controller p 439 N86-32992
Manual control of unstable systems p 441 N86-33008
Modified superposition: A simple time series approach to closed-loop manual controller identification p 442 N86-33009
**MANUALS**
Elementary design guidelines for CO2 scrubbing with LiOH, technical manual
[AD-A168850] p 444 N86-33022
**MASS**
Radiographic determination of mass of inertial tensors of anatomical segments
[AD-A168581] p 425 N86-32961
**MATERIAL ABSORPTION**
A comparison of the specific absorption rate in a homogeneous man model and a man model containing realistic model bones
[AD-A168547] p 424 N86-32960
**MATHEMATICAL MODELS**
Operator alertness/workload assessment using stochastic model-based analysis of myoelectric signals
[AD-A168567] p 428 N86-32973
Operator alertness/workload assessment using stochastic model-based analysis of myoelectric signals
[AD-A168568] p 429 N86-32974
Descriptive Linear modeling of steady-state visual evoked response p 436 N86-32977
Modified Petri net model sensitivity to workload manipulations p 436 N86-32979
A model for the human's use of visual field cues in nap-of-the-Earth flight p 441 N86-33004
Optimal cooperative control synthesis of actve displays p 441 N86-33006
**MEDICAL EQUIPMENT**
Method of high-precision microsampled blood and plasma mass densitometry p 419 A86-49250
**MEDICAL SERVICES**
Activities report on physical and psychological health of flying personnel
[ETN-86-97385] p 423 N86-32093
Activities report on physical and psychological health of flying personnel
[ETN-86-97386] p 423 N86-32094
**MEMORY**
Spectral-correlation characteristics of EEG in the course of short-term memory tests. I - A study of spectral-correlation parameters of the potentials in the human neocortex during correct short-term memorizing p 419 A86-49263
Memory and subjective workload assessment p 437 N86-32983
**MENTAL PERFORMANCE**
The use of cardiac-rhythm statistical characteristics in evaluating mental work capacity p 420 A86-49265
Development of intuitive theories of motion - Curvilinear motion in the absence of external forces p 426 A86-49521
Correlational rhythmography applied to persons of different age under functional loads p 422 A86-49920
Modified Petri net model sensitivity to workload manipulations p 436 N86-32979
The impact of physical and mental tasks on pilot mental workoad p 437 N86-32982
Memory and subjective workload assessment p 437 N86-32983
The effects of acceleration stress on human workload and manual control p 437 N86-32984
Knowledge-based load leveling and task allocation in human-machine systems p 437 N86-32985
The effects of voice and manual control mode on dual task performance p 438 N86-32987
Evaluation of 2 cognitive abilities tests in a dual-task environment p 438 N86-32988
At least some errors are randomly generated (Freud was wrong) p 438 N86-32989
Flight test of a displacement sidearm controller p 439 N86-32992
**METABOLISM**
Biochemical responses of Xenopus Laevis muscles to changes in environment. I. - Comparison to Rana Catesbeiana and exposure to gravic environment p 415 A86-50288
Biochemical responses of Xenopus laevis muscles to changes in environment. II - Responses to gravity and pressure p 415 A86-50289
Gas exchange characteristics of leaves as indicators of the basic limitations to the rate of photosynthesis
[DE86-009632] p 416 N86-32085
**MICROCOMPUTERS**
Automated anthropometric data measurement system
[AD-D012299] p 443 N86-33017
**MICROPROCESSORS**
Variable contrast direct read-out vision tester
[AD-D012273] p 423 N86-32955
**MICROWAVES**
A comparison of the specific absorption rate in a homogeneous man model and a man model containing realistic model bones
[AD-A168547] p 424 N86-32960
**MILITARY OPERATIONS**
Effect of oxygen flow on passenger face mask performance
[AD-A168832] p 443 N86-33021
**MIST**
Controlled environment life support system: Growth studies with potatoes
[NASA-CR-177400] p 434 N86-32101
**MOLECULAR BIOLOGY**
Structural correlates of aging in Drosophila - Relevance to the cell differentiation, rate-of-living and free radical theories of aging p 415 A86-49999
**MONKEYS**
Evaluation of the need for a large primate research facility in space
[NASA-CR-179661] p 444 N86-32111
Growth and development of rhesus monkeys exposed to ELF (Extremely Low Frequency) electric and magnetic fields during the first 54 months of life
[AD-A168733] p 417 N86-32953
**MOTION**
Development of intuitive theories of motion - Curvilinear motion in the absence of external forces p 426 A86-49521
**MULTIPROCESSING (COMPUTERS)**
Development of a hierarchical multiprocessor control for a polyarticulated mechanical structure used to study human operators subjected to vibrations --- French thesis p 433 A86-48553
**MUSCLES**
The startle reflex as a learning task: Apparatus and test parameters
[AD-A167958] p 428 N86-32970
Operator alertness/workload assessment using stochastic model-based analysis of myoelectric signals
[AD-A168567] p 428 N86-32973
Operator alertness/workload assessment using stochastic model-based analysis of myoelectric signals
[AD-A168568] p 429 N86-32974
**MUSCULAR FUNCTION**
Effect of inactivity and passive stretch on protein turnover in phasic and postural rat muscles p 413 A86-47871
On marching to two different drummers - Perceptual aspects of the difficulties p 426 A86-49870
Effects of hypodynamia and neuroemotional stress on the performance of circulatory and respiratory systems during muscular work p 422 A86-49919

Biochemical responses of Xenopus Laevis muscles to changes in environment. I. - Comparison to Rana Catesbeiana and exposure to gravic environment p 415 A86-50288
Biochemical responses of Xenopus laevis muscles to changes in environment. II - Responses to gravity and pressure p 415 A86-50289
Investigation of limb-sidestick dynamic interaction with roll control p 438 N86-32991

## N

**NAP-OF-THE-EARTH NAVIGATION**
A model of the human's use of visual field cues in nap-of-the-earth flight [AIAA PAPER 86-2252] p 426 A86-47498
A model for the human's use of visual field cues in nap-of-the-Earth flight p 441 N86-33004
**NASA PROGRAMS**
Evaluation of the need for a large primate research facility in space [NASA-CR-179661] p 444 N86-32111
**NERVES**
Peripheral nerve injury in developing rats reorganizes motor cortex [AD-A168019] p 417 N86-32952
A model of the transient part of the spatio-temporal perception, containing a two-dimensional long fiber [ETN-86-97540] p 426 N86-32966
**NEUROLOGY**
Analytical comparison of transient and steady state visual evoked cortical potentials p 436 N86-32978
**NEUROPHYSIOLOGY**
Dynamics of the cupula in the semicircular canal of the vestibular analyzer --- Russian book p 421 A86-49339
The retinal cycle in bacteriorhodopsin --- Russian book p 414 A86-49348
**NEUROTRANSMITTERS**
Effect of nerve block on response of forearm blood flow to local temperature p 418 A86-47873
**NICOTINIC ACID**
Changes in the blood coagulation system of rabbits under conditions of acute hypoxia and some methods of its correction p 414 A86-49368
**NIGHT VISION**
Night vision compatible illumination for vehicle crewmember workspace [AD-D012339] p 443 N86-33018
**NONLINEAR SYSTEMS**
Nonlinear mechanisms in physiology and pathophysiology Toward a dynamical theory of health and disease p 422 A86-49636
**NORADRENALINE**
The effect of noradrenaline on oxidation metabolism in cold-adapted golden hamsters p 413 A86-49155
**NOREPINEPHRINE**
The activity of cholinesterase and norepinephrine after laser irradiation of acupuncture points p 414 A86-49921
**NUMERICAL ANALYSIS**
Nonlinear mechanisms in physiology and pathophysiology Toward a dynamical theory of health and disease p 422 A86-49636

## O

**OPERATOR PERFORMANCE**
The use of cardiac-rhythm statistical characteristics in evaluating mental work capacity p 420 A86-49265
A quick method for evaluating operators' work capacity p 420 A86-49268
EEG correlates in the process of forming driving skills p 421 A86-49273
The effect of centedrin on the work capacity of operators p 426 A86-49371
Aiding the operator during novel fault diagnosis p 426 A86-49633
Control loops with human operators in space operations. Part 3: Rendezvous and docking operations and model analysis of performance with human-in-the-loop [NLR-TR-84116-L-PT-3] p 435 N86-32108
Operator alertness/workload assessment using stochastic model-based analysis of myoelectric signals [AD-A168567] p 428 N86-32973
Operator alertness/workload assessment using stochastic model-based analysis of myoelectric signals [AD-A168568] p 429 N86-32974
Levels of Information Processing in a Fitts law task (LIPFitts) p 436 N86-32980
Memory and subjective workload assessment p 437 N86-32983
Investigation of crew performance in a multi-vehicle supervisory control task p 440 N86-33001
Force/torque display for space teleoperation control experiments and evaluation p 440 N86-33002
Model analysis of remotely controlled rendezvous and docking with display prediction p 441 N86-33003
Some computational techniques for estimating human operator describing functions p 441 N86-33007
Comparison of the STI NIPIP tracking dynamics identification with the on-line Fourier analyzer DFA results including a time varying case p 442 N86-33010
Control loops with human operators in space operations. Part 2: Robotics operations and manual control experiment [NLR-TR-84116-L-PT-2] p 444 N86-33024
**OPTICAL EQUIPMENT**
Variable contrast direct read-out vision tester [AD-D012273] p 423 N86-32955
**OPTICAL TRACKING**
Investigating the ocular fixation of targets as an anthropotechnical research method in man-machine systems p 433 A86-47772
The effect of centedrin on the work capacity of operators p 426 A86-49371
**OPTIMAL CONTROL**
Control theoretic analysis of human operator mediated rendezvous and docking [NLR-MP-85020-U] p 435 N86-32106
Optimal cooperative control synthesis of active displays p 441 N86-33006
**OPTIMIZATION**
Evaluation of man-machine systems - Introduction and overview p 432 A86-47767
**ORBITAL ASSEMBLY**
Control loops with human operators in space operations. Part 2: Robotics operations and manual control experiment [NLR-TR-84116-L-PT-2] p 444 N86-33024
**ORBITAL RENDEZVOUS**
Control loops with human operators in space operations. Part 3: Rendezvous and docking operations and model analysis of performance with human-in-the-loop [NLR-TR-84116-L-PT-3] p 435 N86-32108
**ORGANIZATIONS**
Human Factors Review Plan [DE86-010561] p 444 N86-33023
**ORTHOSTATIC TOLERANCE**
Effect of hydration on some orthostatic and haematological responses to head-up tilt p 419 A86-49225
Fluid and protein shifts after postural changes in humans p 421 A86-49523
**OSCILLATIONS**
Predictors of periodic breathing at altitude [AD-A167947] p 424 N86-32957
**OTOLITH ORGANS**
Development of otoconia in the embryonic chick (Gallus domesticus) p 414 A86-49871
**OXYGEN BREATHING**
Gas exchange characteristics of leaves as indicators of the basic limitations to the rate of photosynthesis [DE86-009632] p 416 N86-32085
**OXYGEN MASKS**
Effect of oxygen flow on passenger face mask performance [AD-A168832] p 443 N86-33021
**OXYGEN METABOLISM**
The effect of noradrenaline on oxidation metabolism in cold-adapted golden hamsters p 413 A86-49155
**OXYGEN SUPPLY EQUIPMENT**
Molecular sieve oxygen generation system (MSOGS) onboard the B-1B bomber p 430 A86-47737
New developments in on board oxygen generators p 430 A86-47740
Development of a portable oxygen system analyzer p 430 A86-47742
Test and evaluation of the B-1B molecular sieve oxygen generating system p 431 A86-47751
Effect of oxygen flow on passenger face mask performance [AD-A168832] p 443 N86-33021

## P

**PANCREAS**
Functional state of the pancreas under conditions of prolonged bed rest p 421 A86-49271
**PANELS**
Variable contrast direct read-out vision tester [AD-D012273] p 423 N86-32955
**PARAMECIA**
Influence of gravity on structure and behavior of Paramecium caudatum [ESA-TT-963] p 416 N86-32087
**PARAMETER IDENTIFICATION**
Maximum normalized acceleration as a flying qualities parameter p 442 N86-33012
**PARAMETERIZATION**
The role of impulse parameters in force variability p 439 N86-32997
**PARTICLE MOTION**
Proton transfer in bacteriorhodopsin --- Russian book p 413 A86-49345
**PASSENGERS**
Effect of oxygen flow on passenger face mask performance [AD-A168832] p 443 N86-33021
**PATHOLOGY**
Nonlinear mechanisms in physiology and pathophysiology Toward a dynamical theory of health and disease p 422 A86-49636
**PATTERN RECOGNITION**
Human problem solving in fault diagnosis tasks [AD-A167397] p 434 N86-32104
Progression-regression effects in tracking repeated patterns p 439 N86-32996
**PATTERN REGISTRATION**
Perspective projection invariants [AD-A167783] p 428 N86-32968
**PERFORMANCE PREDICTION**
Model analysis of remotely controlled rendezvous and docking with display prediction p 441 N86-33003
**PERFORMANCE TESTS**
Development of a portable oxygen system analyzer p 430 A86-47742
Test and evaluation of the B-1B molecular sieve oxygen generating system p 431 A86-47751
**PERIPHERAL CIRCULATION**
The frequency of sister chromatid exchanges in blood cells under prolonged hypokinesia p 421 A86-49272
**PERIPHERAL NERVOUS SYSTEM**
Peripheral nerve injury in developing rats reorganizes motor cortex [AD-A168019] p 417 N86-32952
**PEROXIDES**
The mechanism of the adaptogenic effect of tocopherol in prolonged cold exposure p 414 A86-49367
**PERSONNEL**
A collation of United States Air Force anthropometry [AD-A168485] p 443 N86-33019
Human Factors Review Plan [DE86-010561] p 444 N86-33023
**PERSONNEL SELECTION**
Human Factors Review Plan [DE86-010561] p 444 N86-33023
**PETRI NETS**
Modified Petri net model sensitivity to workload manipulations p 436 N86-32979
**PH**
Effect of hypocapnia on ventral medullary blood flow and pH during hypoxia in cats p 413 A86-47869
**PHENOLOGY**
Seasonal and circadian rhythms in androgen excretion in the extremely continental climate of Trans-Baikal and the BAM region among groups of local nonnative population p 420 A86-49269
**PHONEMES**
Speech analysis based on a model of the auditory system [AD-A167426] p 427 N86-32098
**PHOTOCHEMICAL REACTIONS**
The retinal cycle in bacteriorhodopsin --- Russian book p 414 A86-49348
**PHOTOSENSITIVITY**
Proton transfer in bacteriorhodopsin --- Russian book p 413 A86-49345
Photoactive pigments in halobacteria from the Gavish Sabkha p 415 A86-49998
**PHOTOSYNTHESIS**
Photoactive pigments in halobacteria from the Gavish Sabkha p 415 A86-49998
Gas exchange characteristics of leaves as indicators of the basic limitations to the rate of photosynthesis [DE86-009632] p 416 N86-32085
**PHYSICAL EXAMINATIONS**
Effect of dexamethasone on symptoms of acute mountain sickness at Pikes Peak, Colorado (4300m) [AD-A168662] p 425 N86-32963
**PHYSICAL EXERCISE**
Effect of physical training in humans on the response of isolated fat cells to epinephrine p 418 A86-47868
Changes in immunity under stress p 420 A86-49267
Altitude acclimatization attentuates plasma ammonia during submaximal exercise [AD-A168630] p 425 N86-32962
**PHYSICAL WORK**
Effects of hypodynamia and neuroemotional stress on the performance of circulatory and respiratory systems during muscular work p 422 A86-49919
The impact of physical and mental tasks on pilot mental workoad p 437 N86-32982

**PHYSIOLOGICAL ACCELERATION**
Effects of -Gz centrifugal acceleration upon cardiac output of hamster p 415 A86-50290
**PHYSIOLOGICAL EFFECTS**
Functional state of the pancreas under conditions of prolonged bed rest p 421 A86-49271
Evaluation of the need for a large primate research facility in space
[NASA-CR-179661] p 444 N86-32111
A simulation study of the effects of sleep deprivation, time of watch and length of time on watch on watchstanding effectiveness
[AD-A167729] p 424 N86-32956
Effects of high altitude on neurological and pulmonary function: The effect of high altitude on visual evoked potentials in humans on Mt. Everest
[AD-A168335] p 424 N86-32959
**PHYSIOLOGICAL RESPONSES**
Effect of physical training in humans on the response of isolated fat cells to epinephrine p 418 A86-47868
Aldosterone response to angiotensin II during hypoxemia p 418 A86-47870
A quick method for evaluating operators' work capacity p 420 A86-49268
Biochemical responses of Xenopus Laevis muscles to changes in environment. I. - Comparison to Rana Catesbeiana and exposure to gravic environment p 415 A86-50288
Biochemical responses of Xenopus laevis muscles to changes in environment. II - Responses to gravity and pressure p 415 A86-50289
Peripheral nerve injury in developing rats reorganizes motor cortex
[AD-A168019] p 417 N86-32952
Predictors of periodic breathing at altitude
[AD-A167947] p 424 N86-32957
The startle reflex as a learning task: Apparatus and test parameters
[AD-A167958] p 428 N86-32970
The effects of stimulus modality and task integrality: Predicting dual-task performance and workload from single-task levels p 436 N86-32981
The effects of stress on attentional resources p 437 N86-32986
Some computational techniques for estimating human operator describing functions p 441 N86-33007
Manual control of unstable systems p 441 N86-33008
**PHYSIOLOGICAL TESTS**
An analysis of estimation of pulmonary blood flow by the single-breath method p 413 A86-47872
The use of a constitutional approach in the evaluation of health status p 420 A86-49270
**PHYSIOLOGY**
Nonlinear mechanisms in physiology and pathophysiology Toward a dynamical theory of health and disease p 422 A86-49636
Guard cell biochemistry: Response to environmental stimuli causing changes in gas exchange
[DE86-010287] p 416 N86-32086
**PIGMENTS**
Photoactive pigments in halobacteria from the Gavish Sabkha p 415 A86-49998
**PILOT ERROR**
Speed of work and error rate: Analyses of individual differences in a choice reaction series with a cognitive component
[ESA-TT-944] p 427 N86-32099
Hesitation in tracking induced by a concurrent manual task p 439 N86-32995
**PILOT INDUCED OSCILLATION**
Maximum normalized acceleration as a flying qualities parameter p 442 N86-33012
**PILOT PERFORMANCE**
A model of the human's use of visual field cues in nap-of-the-earth flight
[AIAA PAPER 86-2252] p 426 A86-47498
Application of the method of problem taxonomy to the simulation of human service reliability in the manual steering of aircraft
[MBB-LKE-301/S/PUB/216] p 432 A86-47771
Investigating the ocular fixation of targets as an anthropotechnical research method in man-machine systems p 433 A86-47772
Ergometric examination of the cardiovascular system in flight personnel p 421 A86-49370
Operator alertness/workload assessment using stochastic model-based analysis of myoelectric signals
[AD-A168567] p 428 N86-32973
Operator alertness/workload assessment using stochastic model-based analysis of myoelectric signals
[AD-A168568] p 429 N86-32974
Investigation of pilot behavior within the scope of a training program for handling qualities rating in a ground simulator
[DFVLR-MITT-86-01] p 429 N86-32975
The impact of physical and mental tasks on pilot mental workload p 437 N86-32982
Pilot interface with fly by wire control systems p 438 N86-32990
Investigation of limb-sidestick dynamic interaction with roll control p 438 N86-32991
Flight test of a displacement sidearm controller p 439 N86-32992
Anthropometric considerations for a 4-axis side-arm flight controller p 439 N86-32993
A model for the human's use of visual field cues in nap-of-the-Earth flight p 441 N86-33004
Optimal cooperative control synthesis of active displays p 441 N86-33006
Modified superposition: A simple time series approach to closed-loop manual controller identification p 442 N86-33009
A flight test method for pilot/aircraft analysis p 442 N86-33011
Closed-loop, pilot/vehicle analysis of the approach and landing task p 442 N86-33013
**PILOT TRAINING**
Multitask performance: Predicting success in Naval Aviation primary flight training
[AD-A168246] p 428 N86-32972
**PILOTS (PERSONNEL)**
Development of a hierarchical multiprocessor control for a polyarticulated mechanical structure used to study human operators subjected to vibrations --- French thesis p 433 A86-48553
**POISONS**
In vivo dermal absorption method and system for laboratory animals
[AD-D012325] p 417 N86-32951
**PORTABLE EQUIPMENT**
Development of a portable oxygen system analyzer p 430 A86-47742
**POSITION SENSING**
On-orbit manipulators - Sensory and control approaches
[AIAA PAPER 86-2185] p 429 A86-47467
**POSTURE**
A comparison of postural equilibrium effects following exposure to different ground-based flight trainers p 418 A86-47754
Fluid and protein shifts after postural changes in humans p 421 A86-49523
**POTATOES**
Controlled environment life support system: Growth studies with potatoes
[NASA-CR-177400] p 434 N86-32101
**PREDICTION ANALYSIS TECHNIQUES**
Radiographic determination of mass of inertial tensors of anatomical segments
[AD-A168581] p 425 N86-32961
**PRESSURE BREATHING**
Predictors of periodic breathing at altitude
[AD-A167947] p 424 N86-32957
**PRESSURE EFFECTS**
Biochemical responses of Xenopus laevis muscles to changes in environment. II - Responses to gravity and pressure p 415 A86-50289
**PRESSURE SUITS**
An engineering test and evaluation of several new anti-G valves --- for high performance fighter aircraft p 430 A86-47734
Evaluation of 9.5 PSIA as a suit pressure for prolonged extravehicular activity p 417 A86-47741
Current research on advanced concept anti-G suits p 431 A86-47747
Single stage rapid response anti-G valve p 432 A86-47762
Anti-G suit protection and body position p 432 A86-47764
**PROBLEM SOLVING**
Human problem solving in fault diagnosis tasks
[AD-A167397] p 434 N86-32104
**PROJECTIVE GEOMETRY**
Virtual space and 2-dimensional effects in perspective displays p 441 N86-33005
**PROTECTIVE CLOTHING**
Tactical Life Support System (TLSS) aircrew integrated garment p 431 A86-47746
The changing face of constant wear anti-exposure protection --- of Naval aircrewmen against immersion hypothermia p 431 A86-47749
A new standard for protective headgear - BS 6658 p 431 A86-47752
**PROTEIN METABOLISM**
Effect of inactivity and passive stretch on protein turnover in phasic and postural rat muscles p 413 A86-47871
**PROTEIN SYNTHESIS**
The rhodopsin-like pigments of halobacteria - Light-energy and signal transducers in an archaebacterium p 415 A86-50271
**PROTEINS**
Fluid and protein shifts after postural changes in humans p 421 A86-49523
**PROTON BEAMS**
Proton ejection from bacteriorhodopsin --- Russian book p 413 A86-49346
**PROTONS**
Proton transfer in bacteriorhodopsin --- Russian book p 413 A86-49345
Proton injection into bacteriorhodopsin --- Russian book p 414 A86-49347
**PSYCHOLOGICAL FACTORS**
The psychology of decision making --- military commanders p 427 N86-32096
Absolute judgment versus absolute magnitude estimation to convey information through symbol magnitude changes in CRT displays
[AD-A167059] p 434 N86-32103
**PSYCHOLOGICAL TESTS**
Spectral-correlation characteristics of EEG in the course of short-term memory tests. I - A study of spectral-correlation parameters of the potentials in the human neocortex during correct short-term memorizing p 419 A86-49263
On the interrelationship between different ranges of bioelectric activity of the human brain p 422 A86-49975
Speed of work and error rate: Analyses of individual differences in a choice reaction series with a cognitive component
[ESA-TT-944] p 427 N86-32099
Human factors research in aircrew performance and training
[AD-A167740] p 427 N86-32967
**PSYCHOMOTOR PERFORMANCE**
A 24-hour structure of vigilance under prolonged sleep deprivation: Relationship with performance
[AD-A167399] p 422 N86-32089
Multitask performance: Predicting success in Naval Aviation primary flight training
[AD-A168246] p 428 N86-32972
**PSYCHOPHARMACOLOGY**
The effect of centedrin on the work capacity of operators p 426 A86-49371
**PSYCHOPHYSICS**
Absolute judgment versus absolute magnitude estimation to convey information through symbol magnitude changes in CRT displays
[AD-A167059] p 434 N86-32103
**PSYCHOPHYSIOLOGY**
The use of cardiac-rhythm statistical characteristics in evaluating mental work capacity p 420 A86-49265
A quick method for evaluating operators' work capacity p 420 A86-49268
**PULMONARY CIRCULATION**
An analysis of estimation of pulmonary blood flow by the single-breath method p 413 A86-47872
Pulmonary gas exchange in humans exercising at sea level and simulated altitude p 419 A86-47874
**PURSUIT TRACKING**
Hesitation in tracking induced by a concurrent manual task p 439 N86-32995
**PYROLYTIC MATERIALS**
Inhalation toxicology. Part 6: Evaluation of the relative toxicity of thermal decomposition products from 9 aircraft panel materials
[AD-A168250] p 424 N86-32958

## R

**RADIATION DOSAGE**
Inhalation toxicology. Part 6: Evaluation of the relative toxicity of thermal decomposition products from 9 aircraft panel materials
[AD-A168250] p 424 N86-32958
**RADIATION EFFECTS**
The activity of cholinesterase and norepinephrine after laser irradiation of acupuncture points p 414 A86-49921
**RADIATION HAZARDS**
Air Force technical objective document, Aerospace Medical Division, FY 1987
[AD-A167422] p 423 N86-32090
**RADIO FREQUENCIES**
A comparison of the specific absorption rate in a homogeneous man model and a man model containing realistic model bones
[AD-A168547] p 424 N86-32960
**RADIOGRAPHY**
Radiographic determination of mass of inertial tensors of anatomical segments
[AD-A168581] p 425 N86-32961
**RANDOM ERRORS**
At least some errors are randomly generated (Freud was wrong) p 438 N86-32989

**RAPID EYE MOVEMENT STATE**
Altitude acclimatization (ventilation and chemoresponsiveness) during wakefulness and sleep
[AD-A167738] p 423 N86-32091
**RATS**
External respiration, gas exchange, and blood oxygen parameters in acute methemoglobinemia
[DRIC-T-7663] p 415 N86-32082
Peripheral nerve injury in developing rats reorganizes motor cortex
[AD-A168019] p 417 N86-32952
Inhalation toxicology. Part 6: Evaluation of the relative toxicity of thermal decomposition products from 9 aircraft panel materials
[AD-A168250] p 424 N86-32958
**REACTION TIME**
A 24-hour structure of vigilance under prolonged sleep deprivation: Relationship with performance
[AD-A167399] p 422 N86-32089
Active controllers and the time duration to learn a task p 439 N86-32994
Hesitation in tracking induced by a concurrent manual task p 439 N86-32995
Hitts Law? A test of the relationship between information load and movement precision p 440 N86-32998
**RECOGNITION**
Memory and subjective workload assessment p 437 N86-32983
**REFLEXES**
The startle reflex as a learning task: Apparatus and test parameters
[AD-A167958] p 428 N86-32970
**RELIABILITY ANALYSIS**
Some computational techniques for estimating human operator describing functions p 441 N86-33007
**REMOTE CONTROL**
Model analysis of remotely controlled rendezvous and docking with display prediction p 441 N86-33003
Control of a free-flying robot manipulator system
[NASA-CR-179717] p 443 N86-33016
**REMOTE MANIPULATOR SYSTEM**
Force/torque display for space teleoperation control experiments and evaluation p 440 N86-33002
**RENDEZVOUS GUIDANCE**
Control theoretic analysis of human operator mediated rendezvous and docking
[NLR-MP-85020-U] p 435 N86-32106
Model analysis of remotely controlled rendezvous and docking with display prediction p 441 N86-33003
**REPETITION**
Progression-regression effects in tracking repeated patterns p 439 N86-32996
**RESEARCH AND DEVELOPMENT**
Automation and robotics for Space Station in the twenty-first century
[AIAA PAPER 86-2300] p 434 A86-49552
Control loops with human operators in space operations. Part 4: Research requirements for human-in-the-loop space teleoperator development
[NLR-TR-84116-L-PT-4] p 435 N86-32109
**RESEARCH FACILITIES**
Evaluation of the need for a large primate research facility in space
[NASA-CR-179661] p 444 N86-32111
**RESEARCH MANAGEMENT**
Evaluation of the need for a large primate research facility in space
[NASA-CR-179661] p 444 N86-32111
**RESPIRATION**
In vivo dermal absorption method and system for laboratory animals
[AD-D012325] p 417 N86-32951
Predictors of periodic breathing at altitude
[AD-A167947] p 424 N86-32957
**RESPIRATORS**
'The ACDAR' - Advanced chemical defense aircrew respirator p 430 A86-47735
**RESPIRATORY PHYSIOLOGY**
Effect of hypocapnia on ventral medullary blood flow and pH during hypoxia in cats p 413 A86-47869
Aldosterone response to angiotensin II during hypoxemia p 418 A86-47870
An analysis of estimation of pulmonary blood flow by the single-breath method p 413 A86-47872
Pulmonary gas exchange in humans exercising at sea level and simulated altitude p 419 A86-47874
Nocturnal periodic breathing at altitudes of 6,300 and 8,050 m p 419 A86-47875
Possibility of optimizing respiratory activity by means of biocontrol p 420 A86-49266
External respiration, gas exchange, and blood oxygen parameters in acute methemoglobinemia
[DRIC-T-7663] p 415 N86-32082
**RESPIRATORY REFLEXES**
Possibility of optimizing respiratory activity by means of biocontrol p 420 A86-49266
**RESPONSES**
Complex monitoring performance and the coronary-prone type A behavior pattern
[AD-A168240] p 428 N86-32971
**RHYTHM (BIOLOGY)**
On marching to two different drummers - Perceptual aspects of the difficulties p 426 A86-49870
Correlational rhythmography applied to persons of different age under functional loads p 422 A86-49920
**ROBOTICS**
Design for a goal-oriented telerobotic system
[AIAA PAPER 86-2090] p 429 A86-47440
Development of a hierarchical multiprocessor control for a polyarticulated mechanical structure used to study human operators subjected to vibrations --- French thesis p 433 A86-48553
Automation and robotics for Space Station in the twenty-first century
[AIAA PAPER 86-2300] p 434 A86-49552
Control of a free-flying robot manipulator system
[NASA-CR-179717] p 443 N86-33016
Control loops with human operators in space operations. Part 2: Robotics operations and manual control experiment
[NLR-TR-84116-L-PT-2] p 444 N86-33024
**ROBOTS**
Control of a free-flying robot manipulator system
[NASA-CR-179717] p 443 N86-33016
**RODENTS**
A chinchilla restraint system
[AD-A167408] p 416 N86-32084
**ROLL**
Investigation of limb-sidestick dynamic interaction with roll control p 438 N86-32991

# S

**SAFETY FACTORS**
Zopiclone's residual effect upon actual driving performance versus those of nitrazepam and flunitrazepam
[VK-84-10] p 423 N86-32954
**SCALING LAWS**
Absolute judgment versus absolute magnitude estimation to convey information through symbol magnitude changes in CRT displays
[AD-A167059] p 434 N86-32103
**SCRUBBERS**
Elementary design guidelines for CO2 scrubbing with LiOH, technical manual
[AD-A168850] p 444 N86-33022
**SEA LEVEL**
Pulmonary gas exchange in humans exercising at sea level and simulated altitude p 419 A86-47874
**SEDATIVES**
Zopiclone's residual effect upon actual driving performance versus those of nitrazepam and flunitrazepam
[VK-84-10] p 423 N86-32954
**SEMICIRCULAR CANALS**
Dynamics of the cupula in the semicircular canal of the vestibular analyzer --- Russian book p 421 A86-49339
**SENSORIMOTOR PERFORMANCE**
Spatial organization of components of the visual evoked potentials and the sensorimotor reaction efficiency p 419 A86-49264
EEG correlates in the process of forming driving skills p 421 A86-49273
The effect of centedrin on the work capacity of operators p 426 A86-49371
On marching to two different drummers - Perceptual aspects of the difficulties p 426 A86-49870
Multitask performance: Predicting success in Naval Aviation primary flight training
[AD-A168246] p 428 N86-32972
The role of impulse parameters in force variability p 439 N86-32997
**SENSORY PERCEPTION**
On marching to two different drummers - Perceptual aspects of the difficulties p 426 A86-49870
**SENSORY STIMULATION**
The effects of stimulus modality and task integrality: Predicting dual-task performance and workload from single-task levels p 436 N86-32981
Hitts Law? A test of the relationship between information load and movement precision p 440 N86-32998
**SIEVES**
Molecular sieve oxygen generation system (MSOGS) onboard the B-1B bomber p 430 A86-47737
Test and evaluation of the B-1B molecular sieve oxygen generating system p 431 A86-47751
**SIGNAL ANALYSIS**
Spectral-correlation characteristics of EEG in the course of short-term memory tests. I - A study of spectral-correlation parameters of the potentials in the human neocortex during correct short-term memorizing p 419 A86-49263
On the interrelationship between different ranges of bioelectric activity of the human brain p 422 A86-49975
**SIGNAL MEASUREMENT**
Automated anthropometric data measurement system
[AD-D012299] p 443 N86-33017
**SIGNAL PROCESSING**
Speech analysis based on a model of the auditory system
[AD-A167426] p 427 N86-32098
**SIGNS AND SYMPTOMS**
Effect of dexamethasone on symptoms of acute mountain sickness at Pikes Peak, Colorado (4300m)
[AD-A168662] p 425 N86-32963
**SITTING POSITION**
Anti-G suit protection and body position p 432 A86-47764
**SKIN (ANATOMY)**
In vivo dermal absorption method and system for laboratory animals
[AD-D012325] p 417 N86-32951
**SKIN TEMPERATURE (BIOLOGY)**
Effect of nerve block on response of forearm blood flow to local temperature p 418 A86-47873
**SLEEP**
Altitude acclimatization (ventilation and chemoresponsiveness) during wakefulness and sleep
[AD-A167738] p 423 N86-32091
Predictors of periodic breathing at altitude
[AD-A167947] p 424 N86-32957
**SLEEP DEPRIVATION**
A 24-hour structure of vigilance under prolonged sleep deprivation: Relationship with performance
[AD-A167399] p 422 N86-32089
A simulation study of the effects of sleep deprivation, time of watch and length of time on watch on watchstanding effectiveness
[AD-A167729] p 424 N86-32956
**SMOKE**
Inhalation toxicology. Part 6: Evaluation of the relative toxicity of thermal decomposition products from 9 aircraft panel materials
[AD-A168250] p 424 N86-32958
**SODIUM NITRATES**
External respiration, gas exchange, and blood oxygen parameters in acute methemoglobinemia
[DRIC-T-7663] p 415 N86-32082
**SOFTWARE TOOLS**
Striving for natural usage
[DE86-009402] p 435 N86-32105
**SPACE ADAPTATION SYNDROME**
NASA Workshop on Animal Gravity-Sensing Systems
[NASA-TM-88249] p 417 N86-32950
**SPACE FLIGHT**
Special features of surgical intervention under conditions of weightlessness
[AD-A167916] p 423 N86-32092
**SPACE FLIGHT FEEDING**
NASA Facts: Space Shuttle food systems
[NF-150/1-86] p 434 N86-32102
**SPACE FLIGHT STRESS**
NASA Workshop on Animal Gravity-Sensing Systems
[NASA-TM-88249] p 417 N86-32950
**SPACE FLIGHT TRAINING**
Flight training for Space Shuttle missions p 427 A86-50283
**SPACE MAINTENANCE**
Control of a free-flying robot manipulator system
[NASA-CR-179717] p 443 N86-33016
Control loops with human operators in space operations. Part 2: Robotics operations and manual control experiment
[NLR-TR-84116-L-PT-2] p 444 N86-33024
**SPACE PSYCHOLOGY**
USSR Space Life Sciences Digest, issue 7
[NASA-CR-3922(08)] p 416 N86-32083
**SPACE RATIONS**
NASA Facts: Space Shuttle food systems
[NF-150/1-86] p 434 N86-32102
**SPACE SHUTTLE MISSIONS**
Flight training for Space Shuttle missions p 427 A86-50283
**SPACE SHUTTLES**
NASA Facts: Space Shuttle food systems
[NF-150/1-86] p 434 N86-32102
**SPACE STATIONS**
Design for a goal-oriented telerobotic system
[AIAA PAPER 86-2090] p 429 A86-47440

Automation and robotics for Space Station in the twenty-first century
[AIAA PAPER 86-2300] p 434 A86-49552
Operational medical planning for Space Station
[AIAA PAPER 86-2337] p 421 A86-49560
Control of a free-flying robot manipulator system
[NASA-CR-179717] p 443 N86-33016

**SPACECRAFT CONTROL**
On-orbit manipulators - Sensory and control approaches
[AIAA PAPER 86-2185] p 429 A86-47467
Control theoretic analysis of human operator mediated rendezvous and docking
[NLR-MP-85020-U] p 435 N86-32106
Control loops with human operators in space operations. *Part 3: Rendezvous and docking operations and model* analysis of performance with human-in-the-loop
[NLR-TR-84116-L-PT-3] p 435 N86-32108
Control loops with human operators in space operations. Part 4: Research requirements for human-in-the-loop space teleoperator development
[NLR-TR-84116-L-PT-4] p 435 N86-32109
Control loops with human operators in space operations. *Part 5: Executive summary*
[NLR-TR-84116-L-PT-5] p 435 N86-32110

**SPACECRAFT DESIGN**
Control loops with human operators in space operations. Part 1: Human engineering analysis, synthesis and evaluation techniques
[NLR-TR-84116-L-PT-1] p 435 N86-32107

**SPACECRAFT DOCKING**
*Control theoretic analysis of human operator mediated* rendezvous and docking
[NLR-MP-85020-U] p 435 N86-32106
Control loops with human operators in space operations. Part 3: Rendezvous and docking operations and model analysis of performance with human-in-the-loop
[NLR-TR-84116-L-PT-3] p 435 N86-32108
Model analysis of remotely controlled rendezvous and *docking with display prediction* p 441 N86-33003

**SPACECREWS**
Operational medical planning for Space Station
[AIAA PAPER 86-2337] p 421 A86-49560
Air Force technical objective document, Aerospace Medical Division, FY 1987
[AD-A167422] p 423 N86-32090

**SPATIAL RESOLUTION**
Virtual space and 2-dimensional effects in perspective displays p 441 N86-33005

**SPECIFICATIONS**
Effect of oxygen flow on passenger face mask performance
[AD-A168832] p 443 N86-33021

**SPEECH RECOGNITION**
Speech analysis based on a model of the auditory system
[AD-A167426] p 427 N86-32098

**SPINE**
Development of a mechanical analog of a human spine and viscera p 418 A86-47753

**STEADY STATE**
Descriptive Linear modeling of steady-state visual evoked response p 436 N86-32977

**STEP FUNCTIONS**
Maximum normalized acceleration as a flying qualities parameter p 442 N86-33012

**STEREOSCOPIC VISION**
Perspective projection invariants
[AD-A167783] p 428 N86-32968

**STRESS (PHYSIOLOGY)**
Changes in immunity under stress
p 420 A86-49267
The use of a constitutional approach in the evaluation of health status p 420 A86-49270
Complex monitoring performance and the coronary-prone type A behavior pattern
[AD-A168240] p 428 N86-32971
The effects of stress on attentional resources
p 437 N86-32986

**STRESS (PSYCHOLOGY)**
Changes in immunity under stress
p 420 A86-49267
Effects of hypodynamia and neuroemotional stress on the performance of circulatory and respiratory systems during muscular work p 422 A86-49919
Use of artificial intelligence and psychology in the analysis of command and control --- military commanders
[STC-TM-749] p 427 N86-32095
The psychology of decision making --- military commanders p 427 N86-32096
A simulation study of the effects of sleep deprivation, time of watch and length of time on watch on watchstanding effectiveness
[AD-A167729] p 424 N86-32956
Complex monitoring performance and the coronary-prone type A behavior pattern
[AD-A168240] p 428 N86-32971
The effects of stress on attentional resources
p 437 N86-32986

**STRETCHING**
Effect of inactivity and passive stretch on protein turnover in phasic and postural rat muscles
p 413 A86-47871

**SUBMARINES**
Elementary design guidelines for CO2 scrubbing with LiOH, technical manual
[AD-A168850] p 444 N86-33022

**SUPERPOSITION (MATHEMATICS)**
Modified superposition: A simple time series approach to closed-loop manual controller identification
p 442 N86-33009

**SURFACE TEMPERATURE**
A comparison of the specific absorption rate in a homogeneous man model and a man model containing realistic model bones
[AD-A168547] p 424 N86-32960

**SURGERY**
Special features of surgical intervention under conditions *of weightlessness*
[AD-A167916] p 423 N86-32092

**SURVEYS**
A collation of United States Air Force anthropometry
[AD-A168485] p 443 N86-33019

**SYMBOLS**
Absolute judgment versus absolute magnitude estimation to convey information through symbol *magnitude changes in* CRT displays
[AD-A167059] p 434 N86-32103

**SYSTEM EFFECTIVENESS**
Techniques of asking questions in the evaluation of man-machine systems p 433 A86-47774
A measure of usability --- of man-machine systems
p 433 A86-47775

**SYSTEMS ANALYSIS**
A basic concept for evaluating man-machine systems
p 433 A86-47773

**SYSTEMS SIMULATION**
Artificial intelligence and the Rule Oriented System Simulation (ROSS) language --- military commanders
p 427 N86-32097
Data collection via a quasi-experimental simulation technology. Part 1: Multiple measurement of performance excellence in complex and uncertain managerial tasks
[AD-A167949] p 428 N86-32969

**SYSTEMS STABILITY**
Manual control of unstable systems
p 441 N86-33008

## T

**TACTILE DISCRIMINATION**
Pilot interface with fly by wire control systems
p 438 N86-32990

**TARGET ACQUISITION**
Investigating the ocular fixation of targets as an anthropotechnical research method in man-machine systems p 433 A86-47772

**TASK COMPLEXITY**
*On marching to two different drummers - Perceptual* aspects of the difficulties p 426 A86-49870
Data collection via a quasi-experimental simulation technology. Part 1: Multiple measurement of performance excellence in complex and uncertain managerial tasks
[AD-A167949] p 428 N86-32969
Modified Petri net model sensitivity to workload manipulations p 436 N86-32979
*Levels of Information Processing in a Fitts law task* (LIPFitts) p 436 N86-32980
The effects of stimulus modality and task integrality: Predicting dual-task performance and workload from single-task levels p 436 N86-32981
The impact of physical and mental tasks on pilot mental workload p 437 N86-32982
Memory and subjective workload assessment
p 437 N86-32983
Knowledge-based load leveling and task allocation in human-machine systems p 437 N86-32985
The effects of voice and manual control mode on dual task performance p 438 N86-32987
Evaluation of 2 cognitive abilities tests in a dual-task environment p 438 N86-32988
Active controllers and the time duration to learn a task
p 439 N86-32994
The role of impulse parameters in force variability
p 439 N86-32997
Aircrew coordination and decisionmaking: Peer ratings of video tapes made during a full mission simulation
p 440 N86-32999
Investigation of crew performance in a multi-vehicle supervisory control task p 440 N86-33001
Optimal cooperative control synthesis of active displays p 441 N86-33006
Closed-loop, pilot/vehicle analysis of the approach and landing task p 442 N86-33013

**TASKS**
The startle reflex as a learning task: Apparatus and test parameters
[AD-A167958] p 428 N86-32970
A design guide for visual displays and manual tasks in vibration environments. Part 2: Manual tasks
[ISVR-TR-134] p 443 N86-33015

**TELEOPERATORS**
Design for a goal-oriented telerobotic system
[AIAA PAPER 86-2090] p 429 A86-47440
Automation and robotics for Space Station in the twenty-first century
[AIAA PAPER 86-2300] p 434 A86-49552
Control loops with human operators in space operations. Part 1: Human engineering analysis, synthesis and evaluation techniques
[NLR-TR-84116-L-PT-1] p 435 N86-32107
*Control loops with human operators in space operations.* Part 2: Robotics operations and manual control experiment
[NLR-TR-84116-L-PT-2] p 444 N86-33024

**TEMPERATURE EFFECTS**
Effect of nerve block on response of forearm blood flow to local temperature p 418 A86-47873

**TENSORS**
Radiographic determination of mass of inertial tensors of anatomical segments
[AD-A168581] p 425 N86-32961

**TEST EQUIPMENT**
Development of a portable oxygen system analyzer
p 430 A86-47742

**THERMOGRAPHY**
A comparison of the specific absorption rate in a homogeneous man model and a man model containing realistic model bones
[AD-A168547] p 424 N86-32960

**THERMOREGULATION**
The effect of noradrenaline on oxidation metabolism in cold-adapted golden hamsters p 413 A86-49155
The mechanism of the adaptogenic effect of tocopherol in prolonged cold exposure p 414 A86-49367

**THRESHOLDS (PERCEPTION)**
Visibility threshold range observations of LED emergency egress lighting strips and signs through dense smoke and turbid water p 417 A86-47729

**TIME DEPENDENCE**
On marching to two different drummers - Perceptual aspects of the difficulties p 426 A86-49870

**TIME SERIES ANALYSIS**
Modified superposition: A simple time series approach to closed-loop manual controller identification
p 442 N86-33009

**TISSUES (BIOLOGY)**
Proposal for a new tomographic device providing information on the chemical properties of a body section
[DE86-010547] p 425 N86-32964

**TOCOPHEROL**
The mechanism of the adaptogenic effect of tocopherol in prolonged cold exposure p 414 A86-49367

**TOLERANCES (PHYSIOLOGY)**
A chinchilla restraint system
[AD-A167408] p 416 N86-32084
Growth and development of rhesus monkeys exposed to ELF (Extremely Low Frequency) electric and magnetic fields during the first 54 months of life
[AD-A168733] p 417 N86-32953
Radiographic determination of mass of inertial tensors of anatomical segments
[AD-A168581] p 425 N86-32961
Effect of dexamethasone on symptoms of acute mountain sickness at Pikes Peak, Colorado (4300m)
[AD-A168662] p 425 N86-32963

**TOMOGRAPHY**
Proposal for a new tomographic device providing information on the chemical properties of a body section
[DE86-010547] p 425 N86-32964

**TORQUE**
Force/torque display for space teleoperation control experiments and evaluation p 440 N86-33002

**TRAINING ANALYSIS**
*Human Factors Review Plan*
[DE86-010561] p 444 N86-33023

**TRAINING EVALUATION**
Investigation of pilot behavior within the scope of a training program for handling qualities rating in a ground simulator
[DFVLR-MITT-86-01] p 429 N86-32975

**TRAJECTORY CONTROL**
On-orbit manipulators - Sensory and control approaches
[AIAA PAPER 86-2185] p 429 A86-47467
**TRANSFER FUNCTIONS**
Some computational techniques for estimating human operator describing functions p 441 N86-33007
Modified superposition: A simple time series approach to closed-loop manual controller identification p 442 N86-33009
**TRANSPORT AIRCRAFT**
Investigation of pilot behavior within the scope of a training program for handling qualities rating in a ground simulator
[DFVLR-MITT-86-01] p 429 N86-32975

## U

**U.S.S.R.**
USSR Space Life Sciences Digest, issue 7
[NASA-CR-3922(08)] p 416 N86-32083
**UNSTEADY STATE**
Manual control of unstable systems p 441 N86-33008
**USER REQUIREMENTS**
A measure of usability --- of man-machine systems p 433 A86-47775
Striving for natural usage
[DE86-009402] p 435 N86-32105

## V

**VALVES**
An engineering test and evaluation of several new anti-G valves --- for high performance fighter aircraft p 430 A86-47734
**VAPORS**
In vivo dermal absorption method and system for laboratory animals
[AD-D012325] p 417 N86-32951
**VASODILATION**
Aldosterone response to angiotensin II during hypoxemia p 418 A86-47870
**VERBAL COMMUNICATION**
Aircrew coordination and decisionmaking: Peer ratings of video tapes made during a full mission simulation p 440 N86-32999
**VESTIBULES**
Dynamics of the cupula in the semicircular canal of the vestibular analyzer --- Russian book p 421 A86-49339
**VIBRATION DAMPING**
A design guide for visual displays and manual tasks in vibration environments. Part 1: Visual displays
[ISVR-TR-133-PT-1] p 442 N86-33014
A design guide for visual displays and manual tasks in vibration environments. Part 2: Manual tasks
[ISVR-TR-134] p 443 N86-33015
**VIBRATION EFFECTS**
Development of a hierarchical multiprocessor control for a polyarticulated mechanical structure used to study human operators subjected to vibrations --- French thesis p 433 A86-48553
A design guide for visual displays and manual tasks in vibration environments. Part 1: Visual displays
[ISVR-TR-133-PT-1] p 442 N86-33014
A design guide for visual displays and manual tasks in vibration environments. Part 2: Manual tasks
[ISVR-TR-134] p 443 N86-33015
**VIRTUAL PROPERTIES**
Virtual space and 2-dimensional effects in perspective displays p 441 N86-33005
**VISCERA**
Development of a mechanical analog of a human spine and viscera p 418 A86-47753
**VISION**
Variable contrast direct read-out vision tester
[AD-D012273] p 423 N86-32955
**VISUAL DISCRIMINATION**
Speed of work and error rate: Analyses of individual differences in a choice reaction series with a cognitive component
[ESA-TT-944] p 427 N86-32099
**VISUAL FIELDS**
A model of the human's use of visual field cues in nap-of-the-earth flight
[AIAA PAPER 86-2252] p 426 A86-47498
**VISUAL PERCEPTION**
Visibility threshold range observations of LED emergency egress lighting strips and signs through dense smoke and turbid water p 417 A86-47729
Spatial organization of components of the visual evoked potentials and the sensorimotor reaction efficiency p 419 A86-49264
Variable contrast direct read-out vision tester
[AD-D012273] p 423 N86-32955
Implementation of models for the transient division system of spatio-temporal visual perception
[ETN-86-97533] p 425 N86-32965
A model of the transient part of the spatio-temporal perception, containing a two-dimensional long fiber
[ETN-86-97540] p 426 N86-32966
Descriptive Linear modeling of steady-state visual evoked response p 436 N86-32977
Analytical comparison of transient and steady state visual evoked cortical potentials p 436 N86-32978
Force/torque display for space teleoperation control experiments and evaluation p 440 N86-33002
A model for the human's use of visual field cues in nap-of-the-Earth flight p 441 N86-33004
Virtual space and 2-dimensional effects in perspective displays p 441 N86-33005
The development and evaluation of color systems for airborne applications: Fundamental visual, perceptual and display systems considerations
[AD-A168563] p 443 N86-33020
**VISUAL PIGMENTS**
Proton transfer in bacteriorhodopsin --- Russian book p 413 A86-49345
Proton ejection from bacteriorhodopsin --- Russian book p 413 A86-49346
Proton injection into bacteriorhodopsin --- Russian book p 414 A86-49347
The retinal cycle in bacteriorhodopsin --- Russian book p 414 A86-49348
The rhodopsin-like pigments of halobacteria - Light-energy and signal transducers in an archaebacterium p 415 A86-50271
**VISUAL STIMULI**
Auditory versus visual selective-attention tasks
[IZF-1985-19] p 427 N86-32100
**VISUAL TASKS**
Investigating the ocular fixation of targets as an anthropotechnical research method in man-machine systems p 433 A86-47772
Auditory versus visual selective-attention tasks
[IZF-1985-19] p 427 N86-32100
A design guide for visual displays and manual tasks in vibration environments. Part 1: Visual displays
[ISVR-TR-133-PT-1] p 442 N86-33014
**VOICE CONTROL**
The effects of voice and manual control mode on dual task performance p 438 N86-32987

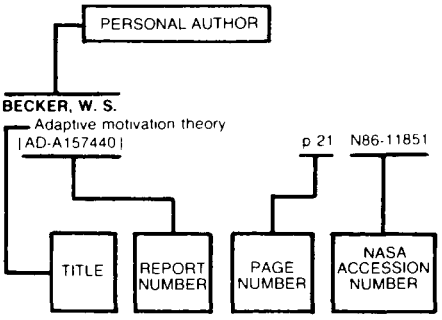
## W

**WARFARE**
Use of artificial intelligence and psychology in the analysis of command and control --- military commanders
[STC-TM-749] p 427 N86-32095
The psychology of decision making --- military commanders p 427 N86-32096
Artificial intelligence and the Rule Oriented System Simulation (ROSS) language --- military commanders p 427 N86-32097
**WATER IMMERSION**
The changing face of constant wear anti-exposure protection --- of Naval aircrewmen against immersion hypothermia p 431 A86-47749
**WEIGHTLESSNESS**
Special features of surgical intervention under conditions of weightlessness
[AD-A167916] p 423 N86-32092
**WEIGHTLESSNESS SIMULATION**
Biochemical responses of Xenopus Laevis muscles to changes in environment. I. - Comparison to Rana Catesbeiana and exposure to gravic environment p 415 A86-50288
Influence of gravity on structure and behavior of Paramecium caudatum
[ESA-TT-963] p 416 N86-32087
**WORK CAPACITY**
The use of cardiac-rhythm statistical characteristics in evaluating mental work capacity p 420 A86-49265
A quick method for evaluating operators' work capacity p 420 A86-49268
The effect of centedrin on the work capacity of operators p 426 A86-49371
**WORKLOADS (PSYCHOPHYSIOLOGY)**
Determination of the load and stress on a cockpit crew during flight using tasking networks and the SAINT simulation language p 432 A86-47770
Techniques of asking questions in the evaluation of man-machine systems p 433 A86-47774
Correlational rhythmography applied to persons of different age under functional loads p 422 A86-49920
A simulation study of the effects of sleep deprivation, time of watch and length of time on watch on watchstanding effectiveness
[AD-A167729] p 424 N86-32956
Twenty-First Annual Conference on Manual Control
[NASA-CP-2428] p 436 N86-32976
Modified Petri net model sensitivity to workload manipulations p 436 N86-32979
Levels of Information Processing in a Fitts law task (LIPFitts) p 436 N86-32980
The effects of stimulus modality and task integrality: Predicting dual-task performance and workload from single-task levels p 436 N86-32981
The impact of physical and mental tasks on pilot mental workload p 437 N86-32982
Memory and subjective workload assessment p 437 N86-32983
The effects of acceleration stress on human workload and manual control p 437 N86-32984
Knowledge-based load leveling and task allocation in human-machine systems p 437 N86-32985
Evaluation of 2 cognitive abilities tests in a dual-task environment p 438 N86-32988
Hitts Law? A test of the relationship between information load and movement precision p 440 N86-32998

## X

**X RAY ANALYSIS**
Proposal for a new tomographic device providing information on the chemical properties of a body section
[DE86-010547] p 425 N86-32964

### Typical Personal Author Index Listing




Listings in this index are arranged alphabetically by personal author. The title of the document provides the user with a brief description of the subject matter. The report number helps to indicate the type of document listed (e.g., NASA report, translation, NASA contractor report). The page and accession numbers are located beneath and to the right of the title. Under any one author's name the accession numbers are arranged in sequence with the AIAA accession numbers appearing first.

## A

**ABBOTT, J. K.**
Inhalation toxicology. Part 6: Evaluation of the relative toxicity of thermal decomposition products from 9 aircraft panel materials
[AD-A168250] p 424 N86-32958

**ACKLES, K. N.**
Tactical Life Support System (TLSS) aircrew integrated garment p 431 A86-47746

**AKIMOV, S. N.**
Ergometric examination of the cardiovascular system in flight personnel p 421 A86-49370

**AKSNES, G.**
Nocturnal periodic breathing at altitudes of 6,300 and 8,050 m p 419 A86-47875

**ALBERY, W. B.**
The effects of acceleration stress on human workload and manual control p 437 N86-32984

**ALEXANDER, H.**
Control of a free-flying robot manipulator system
[NASA-CR-179717] p 443 N86-33016

**ALGERA, R.**
Design of a portable, collapsible hyperbaric chamber p 430 A86-47732

**ALLEN, R. W.**
Manual control of unstable systems p 441 N86-33008

**ALTENKIRCH, D.**
Investigation of pilot behavior within the scope of a training program for handling qualities rating in a ground simulator
[DFVLR-MITT-86-01] p 429 N86-32975

**ANDERSON, L. B.**
The startle reflex as a learning task: Apparatus and test parameters
[AD-A167958] p 428 N86-32970

**ANDERSON, M. R.**
Closed-loop, pilot/vehicle analysis of the approach and landing task p 442 N86-33013

**ANSITE, W. K.**
'The ACDAR' - Advanced chemical defense aircrew respirator p 430 A86-47735

**ARMSTRONG, J. W.**
The development of two prototype facial protection systems for high performance aircrew helmets p 430 A86-47739

**ASIU, B.**
Absolute judgment versus absolute magnitude estimation to convey information through symbol magnitude changes in CRT displays
[AD-A167059] p 434 N86-32103

**AWE, C. A.**
Aircrew coordination and decisionmaking: Peer ratings of video tapes made during a full mission simulation p 440 N86-32999

## B

**BAKALEINIKOVA, V. L.**
Correlational rhythmography applied to persons of different age under functional loads p 422 A86-49920

**BAKANSKAIA, V. V.**
Changes in the blood coagulation system of rabbits under conditions of acute hypoxia and some methods of its correction p 414 A86-49368

**BAKHAREV, V. D.**
The effect of centedrin on the work capacity of operators p 426 A86-49371

**BARTELS, V. I.**
EEG correlates in the process of forming driving skills p 421 A86-49273

**BARTHOLOMEW, J. C.**
Automated anthropometric data measurement system
[AD-D012299] p 443 N86-33017

**BEAUVILLE, M.**
Effect of physical training in humans on the response of isolated fat cells to epinephrine p 418 A86-47868

**BEJCZY, A.**
Force/torque display for space teleoperation control experiments and evaluation p 440 N86-33002

**BELOV, M. A.**
On the interrelationship between different ranges of bioelectric activity of the human brain p 422 A86-49975

**BERG, S. L.**
The impact of physical and mental tasks on pilot mental workload p 437 N86-32982

**BERGQUIST, A. O.**
Development of a portable oxygen system analyzer p 430 A86-47742

**BHARGAVA, V.**
Nonlinear mechanisms in physiology and pathophysiology Toward a dynamical theory of health and disease p 422 A86-49636

**BIEZAD, D. J.**
Modified superposition: A simple time series approach to closed-loop manual controller identification p 442 N86-33009

**BIVIN, D.**
Photoactive pigments in halobacteria from the Gavish Sabkha p 415 A86-49998

**BLACKETT, W. B.**
Effects of high altitude on neuroiogical and pulmonary function: The effect of high altitude on visual evoked potentials in humans on Mt. Everest
[AD-A168335] p 424 N86-32959

**BOBKOVA, N. N.**
The frequency of sister chromatid exchanges in blood cells under prolonged hypokinesia p 421 A86-49272

**BOER, L. C.**
Auditory versus visual selective-attention tasks
[IZF-1985-19] p 427 N86-32100

**BORODIN, iU. B.**
Changes in immunity under stress p 420 A86-49267

**BRAUSER, K.**
Application of the method of problem taxonomy to the simulation of human service reliability in the manual steering of aircraft
[MBB-LKE-301/S/PUB/216] p 432 A86-47771

**BREWER, B. M.**
New developments in on board oxygen generators p 430 A86-47740

**BROOKHUIS, K. A.**
Zopiclone's residual effect upon actual driving performance versus those of nitrazepam and flunitrazepam
[VK-84-10] p 423 N86-32954

**BROTHERS, S. Z.**
The startle reflex as a learning task: Apparatus and test parameters
[AD-A167958] p 428 N86-32970

**BUCHACKER, E.**
A flight test method for pilot/aircraft analysis p 442 N86-33011

**BUICK, F.**
Tactical Life Support System (TLSS) aircrew integrated garment p 431 A86-47746

**BURSE, R. L.**
Effect of dexamethasone on symptoms of acute mountain sickness at Pikes Peak, Colorado (4300m)
[AD-A168662] p 425 N86-32963

**BUZUNOV, V. A.**
Effects of hypodynamia and neuroemotional stress on the performance of circulatory and respiratory systems during muscular work p 422 A86-49919

## C

**CAGLE, C.**
Automated anthropometric data measurement system
[AD-D012299] p 443 N86-33017

**CANNON, R. H., JR.**
Control of a free-flying robot manipulator system
[NASA-CR-179717] p 443 N86-33016

**CARLTON, L. G.**
The role of impulse parameters in force variability p 439 N86-32997

**CARRIER, M., JR.**
A chinchilla restraint system
[AD-A167408] p 416 N86-32084

**CHAN, K.**
A model for the human's use of visual field cues in nap-of-the-Earth flight p 441 N86-33004

**CHAN, K. K.**
A model of the human's use of visual field cues in nap-of-the-earth flight
[AIAA PAPER 86-2252] p 426 A86-47498

**CHIGNELL, M. H.**
Knowledge-based load leveling and task allocation in human-machine systems p 437 N86-32985
The effects of stress on attentional resources p 437 N86-32986

**CHU, Y. Y.**
Operator alertness/workload assessment using stochastic model-based analysis of myoelectric signals
[AD-A168567] p 428 N86-32973
Operator alertness/workload assessment using stochastic model-based analysis of myoelectric signals
[AD-A168568] p 429 N86-32974

**CLEMENT, T.**
Effects of high altitude on neurological and pulmonary function: The effect of high altitude on visual evoked potentials in humans on Mt. Everest
[AD-A168335] p 424 N86-32959

**CLINK, J. P.**
Test and evaluation of the B-1B molecular sieve oxygen generating system p 431 A86-47751

**COLICE, G. L.**
Aldosterone response to angiotensin II during hypoxemia p 418 A86-47870

**COLPITTS, M. R.**
Effects of high altitude on neurological and pulmonary function: The effect of high altitude on visual evoked potentials in humans on Mt. Everest
[AD-A168335] p 424 N86-32959

**COLPITTS, Y.**
Effects of high altitude on neurological and pulmonary function: The effect of high altitude on visual evoked potentials in humans on Mt. Everest
[AD-A168335] p 424 N86-32959

**CONAWAY, C.**
Operator alertness/workload assessment using stochastic model-based analysis of myoelectric signals
[AD-A168567] p 428 N86-32973
Operator alertness/workload assessment using stochastic model-based analysis of myoelectric signals
[AD-A168568] p 429 N86-32974
**CORCORAN, M. L.**
NASA Workshop on Animal Gravity-Sensing Systems
[NASA-TM-88249] p 417 N86-32950
**CORKER, K.**
Force/torque display for space teleoperation control experiments and evaluation p 440 N86-33002
**CRAMPES, F.**
Effect of physical training in humans on the response of isolated fat cells to epinephrine p 418 A86-47868
**CRANE, C. R.**
Inhalation toxicology. Part 6: Evaluation of the relative toxicity of thermal decomposition products from 9 aircraft panel materials
[AD-A168250] p 424 N86-32958
**CROSS, K. D.**
Human factors research in aircrew performance and training
[AD-A167740] p 427 N86-32967
**CULP, V.**
The effects of voice and manual control mode on dual task performance p 438 N86-32987
**CURD, D. L.**
A chinchilla restraint system
[AD-A167408] p 416 N86-32084
**CYMERMAN, A.**
Predictors of periodic breathing at altitude
[AD-A167947] p 424 N86-32957
Effect of dexamethasone on symptoms of acute mountain sickness at Pikes Peak, Colorado (4300m)
[AD-A168662] p 425 N86-32963

## D

**DAMICO, A. D.**
A simulation study of the effects of sleep deprivation, time of watch and length of time on watch on watchstanding effectiveness
[AD-A167729] p 424 N86-32956
**DAVIES, D. G.**
Effect of hypocapnia on ventral medullary blood flow and pH during hypoxia in cats p 413 A86-47869
**DEBELLIS, W. B.**
Anthropometric considerations for a 4-axis side-arm flight controller p 439 N86-32993
**DENBRINKER, A. C.**
Implementation of models for the transient division system of spatio-temporal visual perception
[ETN-86-97533] p 425 N86-32965
A model of the transient part of the spatio-temporal perception, containing a two-dimensional long fiber
[ETN-86-97540] p 426 N86-32966
**DIANAT, S.**
Speech analysis based on a model of the auditory system
[AD-A167426] p 427 N86-32098
**DIXON, G. A.**
Design of a portable, collapsible hyperbaric chamber p 430 A86-47732
Evaluation of 9.5 PSIA as a suit pressure for prolonged extravehicular activity p 417 A86-47741
The relationship of intravascular bubbles to bends at altitude p 418 A86-47765
**DOBRINA, S. K.**
Changes in immunity under stress p 420 A86-49267
**DOCKERY, J. T.**
Use of artificial intelligence and psychology in the analysis of command and control
[STC-TM-749] p 427 N86-32095
**DONOGHUE, J. P.**
Peripheral nerve injury in developing rats reorganizes motor cortex
[AD-A168019] p 417 N86-32952
**DOROFEEV, G. I.**
Ergometric examination of the cardiovascular system in flight personnel p 421 A86-49370
**DURKIN, M. A.**
Effect of nerve block on response of forearm blood flow to local temperature p 418 A86-47873

## E

**EGGEMAN, G. W.**
Improved flexibility of an EVA glove p 433 A86-48713
**EILBART, V. L.**
Seasonal and circadian rhythms in androgen excretion in the extremely continental climate of Trans-Baikal and the BAM region among groups of local nonnative population p 420 A86-49269
**EISERER, M. J.**
Development of a portable oxygen system analyzer p 430 A86-47742
**ELLIS, S. R.**
Virtual space and 2-dimensional effects in perspective displays p 441 N86-33005
**ENDECOTT, B. R.**
Inhalation toxicology. Part 6: Evaluation of the relative toxicity of thermal decomposition products from 9 aircraft panel materials
[AD-A168250] p 424 N86-32958
**ERICKSON, R. T.**
The changing face of constant wear anti-exposure protection p 431 A86-47749
**EVANS, D. G.**
The startle reflex as a learning task: Apparatus and test parameters
[AD-A167958] p 428 N86-32970
**EZZEDINE, H.**
Development of a hierarchical multiprocessor control for a polyarticulated mechanical structure used to study human operators subjected to vibrations p 433 A86-48553

## F

**FALK, L. J.**
Effect of dexamethasone on symptoms of acute mountain sickness at Pikes Peak, Colorado (4300m)
[AD-A168662] p 425 N86-32963
**FERMIN, C. D.**
Development of otoconia in the embryonic chick (Gallus domesticus) p 414 A86-49871
**FISTERE, J.**
User interface description of a gas turbine control system
[ASME PAPER 86-GT-296] p 433 A86-48309
**FLOHRER, W.**
A measure of usability p 433 A86-47775
**FORSTER, E. M.**
Effect of oxygen flow on passenger face mask performance
[AD-A168832] p 443 N86-33021
**FORTE, V. A., JR.**
Altitude acclimatization attentuates plasma ammonia during submaximal exercise
[AD-A168630] p 425 N86-32962
**FRENZEL, H.**
Effects of hypodynamia and neuroemotional stress on the performance of circulatory and respiratory systems during muscular work p 422 A86-49919
**FRICKE, M.**
Determination of the load and stress on a cockpit crew during flight using tasking networks and the SAINT simulation language p 432 A86-47770
**FULCO, C. S.**
Altitude acclimatization attentuates plasma ammonia during submaximal exercise
[AD-A168630] p 425 N86-32962

## G

**GAERTNER, K.-P.**
Evaluation of man-machine systems - Introduction and overview p 432 A86-47767
**GALE, G. E.**
Pulmonary gas exchange in humans exercising at sea level and simulated altitude p 419 A86-47874
**GARG, S.**
Optimal cooperative control synthesis of active displays p 441 N86-33006
**GARGAS, M. L.**
In vivo dermal absorption method and system for laboratory animals
[AD-D012325] p 417 N86-32951
**GARRIGUES, M.**
Effect of physical training in humans on the response of isolated fat cells to epinephrine p 418 A86-47868
**GARSHNEK, V.**
USSR Space Life Sciences Digest, issue 7
[NASA-CR-3922(08)] p 416 N86-32083
**GATTI, E.**
Proposal for a new tomographic device providing information on the chemical properties of a body section
[DE86-010547] p 425 N86-32964
**GAUTIER, I. M. L.**
A chinchilla restraint system
[AD-A167408] p 416 N86-32084
**GDOWIK, C.**
Improvements and modifications to naval helicopter helmets p 431 A86-47761
**GENCO, L. V.**
Variable contrast direct read-out vision tester
[AD-D012273] p 423 N86-32955
**GILL, R. T.**
The effects of acceleration stress on human workload and manual control p 437 N86-32984
**GLAISTER, D. H.**
A new standard for protective headgear - BS 6658 p 431 A86-47752
**GLEESON, K.**
Altitude acclimatization (ventilation and chemoresponsiveness) during wakefulness and sleep
[AD-A167738] p 423 N86-32091
Predictors of periodic breathing at altitude
[AD-A167947] p 424 N86-32957
**GLOERICH, A. B. M.**
Zopiclone's residual effect upon actual driving performance versus those of nitrazepam and flunitrazepam
[VK-84-10] p 423 N86-32954
**GOETERS, K. M.**
Speed of work and error rate: Analyses of individual differences in a choice reaction series with a cognitive component
[ESA-TT-944] p 427 N86-32099
**GOLDBERGER, A. L.**
Nonlinear mechanisms in physiology and pathophysiology Toward a dynamical theory of health and disease p 422 A86-49636
**GOLDSPINK, D. F.**
Effect of inactivity and passive stretch on protein turnover in phasic and postural rat muscles p 413 A86-47871
**GOLDSPINK, G.**
Effect of inactivity and passive stretch on protein turnover in phasic and postural rat muscles p 413 A86-47871
**GOODYEAR, C.**
Active controllers and the time duration to learn a task p 439 N86-32994
**GREENLEAF, J. E.**
Effect of hydration on some orthostatic and haematological responses to head-up tilt p 419 A86-49225
**GRIFFIN, G. R.**
Multitask performance: Predicting success in Naval Aviation primary flight training
[AD-A168246] p 428 N86-32972
**GRIFFIN, M. J.**
A design guide for visual displays and manual tasks in vibration environments. Part 1: Visual displays
[ISVR-TR-133-PT-1] p 442 N86-33014
A design guide for visual displays and manual tasks in vibration environments. Part 2: Manual tasks
[ISVR-TR-134] p 443 N86-33015
**GRINER, T. A.**
Growth and development of rhesus monkeys exposed to ELF (Extremely Low Frequency) electric and magnetic fields during the first 54 months of life
[AD-A168733] p 417 N86-32953
A comparison of the specific absorption rate in a homogeneous man model and a man model containing realistic model bones
[AD-A168547] p 424 N86-32960
**GRISSETT, J. D.**
Growth and development of rhesus monkeys exposed to ELF (Extremely Low Frequency) electric and magnetic fields during the first 54 months of life
[AD-A168733] p 417 N86-32953
**GROSS, H. G.**
Visibility threshold range observations of LED emergency egress lighting strips and signs through dense smoke and turbid water p 417 A86-47729

## H

**HAH, S.**
Progression-regression effects in tracking repeated patterns p 439 N86-32996
**HAMMER, J. M.**
Aiding the operator during novel fault diagnosis p 426 A86-49633
**HANCOCK, P. A.**
Knowledge-based load leveling and task allocation in human-machine systems p 437 N86-32985
The effects of stress on attentional resources p 437 N86-32986
**HANSON, G.**
Comparison of the STI NIPIP tracking dynamics identification with the on-line Fourier analyzer DFA results including a time varying case p 442 N86-33010

**HARGETT, C. E., JR.**
A chinchilla restraint system
[AD-A167408] p 416 N86-32084
**HARRISON, M. H.**
Effect of hydration on some orthostatic and haematological responses to head-up tilt
p 419 A86-49225
**HART, S.**
Memory and subjective workload assessment
p 437 N86-32983
**HART, S. G.**
Levels of Information Processing in a Fitts law task (LIPFitts) p 436 N86-32980
The effects of stimulus modality and task integrality: Predicting dual-task performance and workload from single-task levels p 436 N86-32981
**HASEGAWA, H.**
Biochemical responses of Xenopus laevis muscles to changes in environment. II - Responses to gravity and pressure p 415 A86-50289
**HASWELL, M. S.**
Effect of oxygen flow on passenger face mask performance
[AD-A168832] p 443 N86-33021
**HAY, R. P.**
Improvements and modifications to naval helicopter helmets p 431 A86-47761
**HELD, J. J.**
Improved flexibility of an EVA glove
p 433 A86-48713
**HEMMERSBACH, R.**
Influence of gravity on structure and behavior of Paramecium caudatum
[ESA-TT-963] p 416 N86-32087
**HENDLER, E.**
Anti-G suit protection and body position
p 432 A86-47764
**HESS, R. A.**
A model of the human's use of visual field cues in nap-of-the-earth flight
[AIAA PAPER 86-2252] p 426 A86-47498
A model for the human's use of visual field cues in nap-of-the-Earth flight p 441 N86-33004
**HILL, L. C.**
Effect of hydration on some orthostatic and haematological responses to head-up tilt
p 419 A86-49225
**HILL, M. D.**
On marching to two different drummers - Perceptual aspects of the difficulties p 426 A86-49870
**HINGHOFER-SZALKAY, H.**
Method of high-precision microsampled blood and plasma mass densitometry p 419 A86-49250
Fluid and protein shifts after postural changes in humans p 421 A86-49523
**HOCHSTEIN, L. I.**
Halobacterium denitrificans sp. nov. - An extremely halophilic denitrifying bacterium p 414 A86-49524
**HOGUE, J. R.**
Manual control of unstable systems
p 441 N86-33008
**HOLDEN, R. D.**
Development of a portable oxygen system analyzer
p 430 A86-47742
Effect of oxygen flow on passenger face mask performance
[AD-A168832] p 443 N86-33021
**HOOKE, L. R.**
USSR Space Life Sciences Digest, issue 7
[NASA-CR-3922(08)] p 416 N86-32083
**HOUDE, R. A.**
Speech analysis based on a model of the auditory system
[AD-A167426] p 427 N86-32098
**HREBIN, L.**
Anti-G suit protection and body position
p 432 A86-47764
**HUGHES, F. E.**
Flight training for Space Shuttle missions
p 427 A86-50283
**HUGHES, R. E.**
Automated anthropometric data measurement system
[AD-D012299] p 443 N86-33017
**HUNT, R. M.**
Human problem solving in fault diagnosis tasks
[AD-A167397] p 434 N86-32104
**HUTCHINSON, S. L.**
The startle reflex as a learning task: Apparatus and test parameters
[AD-A167958] p 428 N86-32970

## I

**IBANEZ, P.**
Radiographic determination of mass of inertial tensors of anatomical segments
[AD-A168581] p 425 N86-32961
**IGARASHI, M.**
Development of otoconia in the embryonic chick (Gallus domesticus) p 414 A86-49871
**IKAWA, S.**
Biochemical responses of Xenopus Laevis muscles to changes in environment. I. - Comparison to Rana Catesbeiana and exposure to gravic environment
p 415 A86-50288
Biochemical responses of Xenopus laevis muscles to changes in environment. II - Responses to gravity and pressure p 415 A86-50289

## J

**JAGACINSKI, R. J.**
On marching to two different drummers - Perceptual aspects of the difficulties p 426 A86-49870
Twenty-First Annual Conference on Manual Control
[NASA-CP-2428] p 436 N86-32976
Progression-regression effects in tracking repeated patterns p 439 N86-32996
Investigation of crew performance in a multi-vehicle supervisory control task p 440 N86-33001
**JAHNKE, L. L.**
Halobacterium denitrificans sp. nov. - An extremely halophilic denitrifying bacterium p 414 A86-49524
**JEPSON, G. W.**
In vivo dermal absorption method and system for laboratory animals
[AD-D012325] p 417 N86-32951
**JEX, H. R.**
Comparison of the STI NIPIP tracking dynamics identification with the on-line Fourier analyzer DFA results including a time varying case p 442 N86-33010
**JOHNSON, T. S.**
Effect of dexamethasone on symptoms of acute mountain sickness at Pikes Peak, Colorado (4300m)
[AD-A168662] p 425 N86-32963
**JOHNSTON, D. E.**
Investigation of limb-sidestick dynamic interaction with roll control p 438 N86-32991
**JUNKER, A. M.**
Descriptive Linear modeling of steady-state visual evoked response p 436 N86-32977
Analytical comparison of transient and steady state visual evoked cortical potentials p 436 N86-32978

## K

**KAISER, M. K.**
Development of intuitive theories of motion - Curvilinear motion in the absence of external forces
p 426 A86-49521
**KAMPEN, S.**
Control loops with human operators in space operations. Part 2: Robotics operations and manual control experiment
[NLR-TR-84116-L-PT-2] p 444 N86-33024
**KARPENKO, A. V.**
The use of cardiac-rhythm statistical characteristics in evaluating mental work capacity p 420 A86-49265
**KAUFMAN, E.**
A simulation study of the effects of sleep deprivation, time of watch and length of time on watch on watchstanding effectiveness
[AD-A167729] p 424 N86-32956
**KAZNACHEEV, S. V.**
The use of a constitutional approach in the evaluation of health status p 420 A86-49270
**KELLY, P. A.**
Hesitation in tracking induced by a concurrent manual task p 439 N86-32995
**KEMMER, J.**
Proposal for a new tomographic device providing information on the chemical properties of a body section
[DE86-010547] p 425 N86-32964
**KENNEDY, K. W.**
A collation of United States Air Force anthropometry
[AD-A168485] p 443 N86-33019
**KENNEDY, R. S.**
A comparison of postural equilibrium effects following exposure to different ground-based flight trainers
p 418 A86-47754
**KENNER, K.**
Descriptive Linear modeling of steady-state visual evoked response p 436 N86-32977
**KENNER, K. M.**
Analytical comparison of transient and steady state visual evoked cortical potentials p 436 N86-32978
**KING, M.**
Flight test of a displacement sidearm controller
p 439 N86-32992
**KIRCHNER, J.-H.**
A basic concept for evaluating man-machine systems
p 433 A86-47773
**KIRLIK, A. C.**
Investigation of crew performance in a multi-vehicle supervisory control task p 440 N86-33001
**KLAPP, S. T.**
On marching to two different drummers - Perceptual aspects of the difficulties p 426 A86-49870
Hesitation in tracking induced by a concurrent manual task p 439 N86-32995
**KLEINMAN, D. L.**
Analytical comparison of transient and steady state visual evoked cortical potentials p 436 N86-32978
An experimental paradigm for team decision processes p 440 N86-33000
**KOCHUBEEV, A. V.**
Possibility of optimizing respiratory activity by means of biocontrol p 420 A86-49266
**KOEHLER, R.**
A flight test method for pilot/aircraft analysis
p 442 N86-33011
**KOLOSOVA, N. G.**
The mechanism of the adaptogenic effect of tocopherol in prolonged cold exposure p 414 A86-49367
**KONDRACHUK, A. V.**
Dynamics of the cupula in the semicircular canal of the vestibular analyzer p 421 A86-49339
**KOPP, U.**
Determination of the load and stress on a cockpit crew during flight using tasking networks and the SAINT simulation language p 432 A86-47770
**KOROLKOVA, T. A.**
Spectral-correlation characteristics of EEG in the course of short-term memory tests. I - A study of spectral-correlation parameters of the potentials in the human neocortex during correct short-term memorizing
p 419 A86-49263
**KRASNOGOLOVETS, V. V.**
Proton transfer in bacteriorhodopsin
p 413 A86-49345
Proton ejection from bacteriorhodopsin
p 413 A86-49346
Proton injection into bacteriorhodopsin
p 414 A86-49347
The retinal cycle in bacteriorhodopsin
p 414 A86-49348
**KRUEGER, A. G.**
An engineering test and evaluation of several new anti-G valves p 430 A86-47734
**KRUK, R.**
Flight test of a displacement sidearm controller
p 439 N86-32992
**KRUTZ, R.**
Evaluation of 9.5 PSIA as a suit pressure for prolonged extravehicular activity p 417 A86-47741
**KRUTZ, R. W.**
The relationship of intravascular bubbles to bends at altitude p 418 A86-47765
**KULIKOV, V. IU.**
The mechanism of the adaptogenic effect of tocopherol in prolonged cold exposure p 414 A86-49367

## L

**LAM, W.**
Single stage rapid response anti-G valve
p 432 A86-47762
**LAURIG, W.**
Techniques of asking questions in the evaluation of man-machine systems p 433 A86-47774
**LAVIE, P.**
A 24-hour structure of vigilance under prolonged sleep deprivation: Relationship with performance
[AD-A167399] p 422 N86-32089
**LEBAN, F.**
Modified superposition: A simple time series approach to closed-loop manual controller identification
p 442 N86-33009
**LEVISON, W. H.**
Descriptive Linear modeling of steady-state visual evoked response p 436 N86-32977
Some computational techniques for estimating human operator describing functions p 441 N86-33007
**LEWIS, C. M.**
Issues in rule identification and logical induction
p 434 A86-49634

**LILIENTHAL, M. G.**
A comparison of postural equilibrium effects following exposure to different ground-based flight trainers p 418 A86-47754
**LIPPAY, A. L.**
Flight test of a displacement sidearm controller p 439 N86-32992
**LOTZ, W. G.**
Growth and development of rhesus monkeys exposed to ELF (Extremely Low Frequency) electric and magnetic fields during the first 54 months of life [AD-A168733] p 417 N86-32953
**LOUGHNA, P.**
Effect of inactivity and passive stretch on protein turnover in phasic and postural rat muscles p 413 A86-47871
**LOUWERENS, J. W.**
Zopiclone's residual effect upon actual driving performance versus those of nitrazepam and flunitrazepam [VK-84-10] p 423 N86-32954
**LOVE, P.E.**
An engineering test and evaluation of several new anti-G valves p 430 A86-47734
**LUCIANI, R. J.**
Operational medical planning for Space Station [AIAA PAPER 86-2337] p 421 A86-49560
**LUPYR, V. M.**
The activity of cholinesterase and norepinephrine after laser irradiation of acupuncture points p 414 A86-49921
**LYMAN, J.**
Modified Petri net model sensitivity to workload manipulations p 436 N86-32979

## M

**MACKINNON, D. P.**
Modified Petri net model sensitivity to workload manipulations p 436 N86-32979
**MADNI, A.**
Operator alertness/workload assessment using stochastic model-based analysis of myoelectric signals [AD-A168567] p 428 N86-32973
Operator alertness/workload assessment using stochastic model-based analysis of myoelectric signals [AD-A168568] p 429 N86-32974
**MANKOV, IU. U.**
The effect of centedrin on the work capacity of operators p 426 A86-49371
**MARET, K. H.**
Nocturnal periodic breathing at altitudes of 6,300 and 8,050 m p 419 A86-47875
**MARSHAK, W.**
The effects of voice and manual control mode on dual task performance p 438 N86-32987
**MARTIN, Z. E.**
On marching to two different drummers - Perceptual aspects of the difficulties p 426 A86-49870
**MASHIKO, S.**
Modified superposition: A simple time series approach to closed-loop manual controller identification p 442 N86-33009
**MASLENNIKOVA, L. S.**
The effect of noradrenaline on oxidation metabolism in cold-adapted golden hamsters p 413 A86-49155
**MASUDA, M.**
Biochemical responses of Xenopus Laevis muscles to changes in environment. I. - Comparison to Rana Catesbeiana and exposure to gravic environment p 415 A86-50288
Biochemical responses of Xenopus laevis muscles to changes in environment. II - Responses to gravity and pressure p 415 A86-50289
**MCBRIDE, D. K.**
Multitask performance: Predicting success in Naval Aviation primary flight training [AD-A168246] p 428 N86-32972
**MCCLOSKEY, M.**
Development of intuitive theories of motion - Curvilinear motion in the absence of external forces p 426 A86-49521
**MCCLURG, T. D.**
Analytical comparison of transient and steady state visual evoked cortical potentials p 436 N86-32978
**MCDOUGAL, J. N.**
In vivo dermal absorption method and system for laboratory animals [AD-D012325] p 417 N86-32951
**MCGINNIS, K.**
Photoactive pigments in halobacteria from the Gavish Sabkha p 415 A86-49998
**MCGREEVY, M. W.**
Virtual space and 2-dimensional effects in perspective displays p 441 N86-33005
**MCLAUGHLIN, J.**
On-orbit manipulators - Sensory and control approaches [AIAA PAPER 86-2185] p 429 A86-47467
**MCLEOD, R. W.**
A design guide for visual displays and manual tasks in vibration environments. Part 2: Manual tasks [ISVR-TR-134] p 443 N86-33015
**MCRUER, D. T.**
Investigation of limb-sidestick dynamic interaction with roll control p 438 N86-32991
**MEDKOVA, I. L.**
Functional state of the pancreas under conditions of prolonged bed rest p 421 A86-49271
**MEDVEDEV, S. V.**
On the interrelationship between different ranges of bioelectric activity of the human brain p 422 A86-49975
**MEEKER, L. J.**
An engineering test and evaluation of several new anti-G valves p 430 A86-47734
**MELVIN, W. W.**
Pilot interface with fly by wire control systems p 438 N86-32990
**MERKLE, P. J., JR.**
A comparison of postural equilibrium effects following exposure to different ground-based flight trainers p 418 A86-47754
**MERRIFIELD, R. M.**
The development and evaluation of color systems for airborne applications: Fundamental visual, perceptual and display systems considerations [AD-A168563] p 443 N86-33020
**MICHAS, R. D.**
Tactical Life Support System (TLSS) aircrew integrated garment p 431 A86-47746
**MILGRAM, P.**
Control theoretic analysis of human operator mediated rendezvous and docking [NLR-MP-85020-U] p 435 N86-32106
Control loops with human operators in space operations. Part 1: Human engineering analysis, synthesis and evaluation techniques [NLR-TR-84116-L-PT-1] p 435 N86-32107
Control loops with human operators in space operations. Part 3: Rendezvous and docking operations and model analysis of performance with human-in-the-loop [NLR-TR-84116-L-PT-3] p 435 N86-32108
Control loops with human operators in space operations. Part 4: Research requirements for human-in-the-loop space teleoperator development [NLR-TR-84116-L-PT-4] p 435 N86-32109
Control loops with human operators in space operations. Part 5: Executive summary [NLR-TR-84116-L-PT-5] p 435 N86-32110
Model analysis of remotely controlled rendezvous and docking with display prediction p 441 N86-33003
**MILLEDGE, J. S.**
Nocturnal periodic breathing at altitudes of 6,300 and 8,050 m p 419 A86-47875
**MILLER, R. A.**
Twenty-First Annual Conference on Manual Control [NASA-CP-2428] p 436 N86-32976
Investigation of crew performance in a multi-vehicle supervisory control task p 440 N86-33001
**MILLER, R. C.**
The effects of stimulus modality and task integrality: Predicting dual-task performance and workload from single-task levels p 436 N86-32981
**MIQUEL, J.**
Structural correlates of aging in Drosophila - Relevance to the cell differentiation, rate-of-living and free radical theories of aging p 415 A86-49999
**MIZUNO, Y.**
Effects of -Gz centrifugal acceleration upon cardiac output of hamster p 415 A86-50290
**MOKROV, M. N.**
Special features of surgical intervention under conditions of weightlessness [AD-A167916] p 423 N86-32092
**MOON, R. E.**
Pulmonary gas exchange in humans exercising at sea level and simulated altitude p 419 A86-47874
**MOORE, A. A.**
The relationship of intravascular bubbles to bends at altitude p 418 A86-47765
**MORAN, D. S.**
Development of a portable oxygen system analyzer p 430 A86-47742
**MORAY, N.**
Hitts Law? A test of the relationship between information load and movement precision p 440 N86-32998
**MORGAN, M.**
Flight test of a displacement sidearm controller p 439 N86-32992
**MORONEY, W. F.**
Automated anthropometric data measurement system [AD-D012299] p 443 N86-33017
**MOSELEY, M. J.**
A design guide for visual displays and manual tasks in vibration environments. Part 1: Visual displays [ISVR-TR-133-PT-1] p 442 N86-33014
**MOSER, M.**
Fluid and protein shifts after postural changes in humans p 421 A86-49523
**MOSIER, K. L.**
Levels of Information Processing in a Fitts law task (LIPFitts) p 436 N86-32980
**MURPHY, B. P.**
Development of a mechanical analog of a human spine and viscera p 418 A86-47753
**MURPHY, M. R.**
Aircrew coordination and decisionmaking: Peer ratings of video tapes made during a full mission simulation p 440 N86-32999

## N

**NAVAKATIKIAN, A. O.**
Effects of hypodynamia and neuroemotional stress on the performance of circulatory and respiratory systems during muscular work p 422 A86-49919
**NAZHIVIN, IU. S.**
A quick method for evaluating operators' work capacity p 420 A86-49268
**NECHAEVA, L. A.**
A quick method for evaluating operators' work capacity p 420 A86-49268
**NEWELL, K. M.**
The role of impulse parameters in force variability p 439 N86-32997
**NEWMAN, J. A.**
The development of two prototype facial protection systems for high performance aircrew helmets p 430 A86-47739
**NICOLO, D. M.**
Improvements and modifications to naval helicopter helmets p 431 A86-47761
**NIEMEYER, D.**
Determination of the load and stress on a cockpit crew during flight using tasking networks and the SAINT simulation language p 432 A86-47770
**NOLAN, W. F.**
Effect of hypocapnia on ventral medullary blood flow and pH during hypoxia in cats p 413 A86-47869
**NORMATOV, A. T.**
Possibility of optimizing respiratory activity by means of biocontrol p 420 A86-49266

## O

**OHANLON, J. F.**
Zopiclone's residual effect upon actual driving performance versus those of nitrazepam and flunitrazepam [VK-84-10] p 423 N86-32954
**OHIRA, M.**
Biochemical responses of Xenopus laevis muscles to changes in environment. II - Responses to gravity and pressure p 415 A86-50289
**OHIRA, Y.**
Biochemical responses of Xenopus Laevis muscles to changes in environment. I. - Comparison to Rana Catesbeiana and exposure to gravic environment p 415 A86-50288
Biochemical responses of Xenopus laevis muscles to changes in environment. II - Responses to gravity and pressure p 415 A86-50289
**OLSEN, R. G.**
A comparison of the specific absorption rate in a homogeneous man model and a man model containing realistic model bones [AD-A168547] p 424 N86-32960
**OLSON, R. M.**
The relationship of intravascular bubbles to bends at altitude p 418 A86-47765
**ONSTOTT, E. D.**
Maximum normalized acceleration as a flying qualities parameter p 442 N86-33012
**ORLOVA, G. S.**
Changes in immunity under stress p 420 A86-49267
**ORLOVA, Z. S.**
Changes in immunity under stress p 420 A86-49267

**OSTROVSKAIA, E. E.**
Spectral-correlation characteristics of EEG in the course of short-term memory tests. I - A study of spectral-correlation parameters of the potentials in the human neocortex during correct short-term memorizing
p 419 A86-49263

**OTSUBU, S.**
Operator alertness/workload assessment using stochastic model-based analysis of myoelectric signals
[AD-A168567] p 428 N86-32973
Operator alertness/workload assessment using stochastic model-based analysis of myoelectric signals
[AD-A168568] p 429 N86-32974

**OUTLAW, W. H., JR.**
Guard cell biochemistry: Response to environmental stimuli causing changes in gas exchange
[DE86-010287] p 416 N86-32086

## P

**PARAMORE, B.**
Human Factors Review Plan
[DE86-010561] p 444 N86-33023

**PARKINS, C. W.**
Speech analysis based on a model of the auditory system
[AD-A167426] p 427 N86-32098

**PARSEGHIAN, Z.**
Manual control of unstable systems
p 441 N86-33008

**PATTERSON, J. H., JR.**
A chinchilla restraint system
[AD-A167408] p 416 N86-32084

**PEDDER, J. B.**
The development of two prototype facial protection systems for high performance aircrew helmets
p 430 A86-47739

**PEROV, B. V.**
EEG correlates in the process of forming driving skills
p 421 A86-49273

**PETERS, R. M., JR.**
Nocturnal periodic breathing at altitudes of 6,300 and 8,050 m p 419 A86-47875

**PETERSON, L. R.**
Human Factors Review Plan
[DE86-010561] p 444 N86-33023

**PHILPOTT, D. E.**
Structural correlates of aging in Drosophila - Relevance to the cell differentiation, rate-of-living and free radical theories of aging p 415 A86-49999

**PIASECKI, M. T.**
Data collection via a quasi-experimental simulation technology. Part 1: Multiple measurement of performance excellence in complex and uncertain managerial tasks
[AD-A167949] p 428 N86-32969

**PICKETT, C. K.**
Altitude acclimatization (ventilation and chemoresponsiveness) during wakefulness and sleep
[AD-A167738] p 423 N86-32091
Predictors of periodic breathing at altitude
[AD-A167947] p 424 N86-32957

**PIERCE, E.**
Operational medical planning for Space Station
[AIAA PAPER 86-2337] p 421 A86-49560

**PIVIROTTO, D. L.**
Automation and robotics for Space Station in the twenty-first century
[AIAA PAPER 86-2300] p 434 A86-49552

**PLAMONDON, B. D.**
Investigation of crew performance in a multi-vehicle supervisory control task p 440 N86-33001

**POGASH, R. M.**
Data collection via a quasi-experimental simulation technology. Part 1: Multiple measurement of performance excellence in complex and uncertain managerial tasks
[AD-A167949] p 428 N86-32969

**POLIAKOV, A. A.**
Correlational rhythmography applied to persons of different age under functional loads p 422 A86-49920

**POLIANTSEV, V. A.**
A quick method for evaluating operators' work capacity p 420 A86-49268

**POST, D. B.**
Elementary design guidelines for CO2 scrubbing with LiOH, technical manual
[AD-A168850] p 444 N86-33022

**POZHAROV, V. P.**
External respiration, gas exchange, and blood oxygen parameters in acute methemoglobinemia
[DRIC-T-7663] p 415 N86-32082

**PROFFITT, D. R.**
Development of intuitive theories of motion - Curvilinear motion in the absence of external forces
p 426 A86-49521

**PROTSENKO, N. A.**
Proton transfer in bacteriorhodopsin
p 413 A86-49345
Proton ejection from bacteriorhodopsin
p 413 A86-49346
Proton injection into bacteriorhodopsin
p 414 A86-49347
The retinal cycle in bacteriorhodopsin
p 414 A86-49348

**PURCELL, D.**
Operator alertness/workload assessment using stochastic model-based analysis of myoelectric signals
[AD-A168568] p 429 N86-32974

## R

**RADTKE, M.**
USSR Space Life Sciences Digest, issue 7
[NASA-CR-3922(08)] p 416 N86-32083

**RAMIREZ, G.**
Aldosterone response to angiotensin II during hypoxemia p 418 A86-47870

***RANNELS, A. M.***
Altitude acclimatization (ventilation and chemoresponsiveness) during wakefulness and sleep
[AD-A167738] p 423 N86-32091
Predictors of periodic breathing at altitude
[AD-A167947] p 424 N86-32957

**RAPPAPORT, B.**
Force/torque display for space teleoperation control experiments and evaluation p 440 N86-33002

**RATAJCZAK, M.**
Single stage rapid response anti-G valve
p 432 A86-47762

**RATZLAFF, C. R.**
Virtual space and 2-dimensional effects in perspective displays p 441 N86-33005

**REEPS, S. M.**
The changing face of constant wear anti-exposure protection p 431 A86-47749

**REEVES, J. T.**
Altitude acclimatization (ventilation and chemoresponsiveness) during wakefulness and sleep
[AD-A167738] p 423 N86-32091
Predictors of periodic breathing at altitude
[AD-A167947] p 424 N86-32957

**REHAK, P.**
Proposal for a new tomographic device providing information on the chemical properties of a body section
[DE86-010547] p 425 N86-32964

**REPPERGER, D. W.**
Active controllers and the time duration to learn a task
p 439 N86-32994

**RESHETIUK, A. L.**
Correlational rhythmography applied to persons of different age under functional loads p 422 A86-49920

**RHODY, H. E.**
Speech analysis based on a model of the auditory system
[AD-A167426] p 427 N86-32098

**RIVIERE, D.**
Effect of physical training in humans on the response of isolated fat cells to epinephrine p 418 A86-47868

**ROCK, P. B.**
Altitude acclimatization attentuates plasma ammonia during submaximal exercise
[AD-A168630] p 425 N86-32962
Effect of dexamethasone on symptoms of acute mountain sickness at Pikes Peak, Colorado (4300m)
[AD-A168662] p 425 N86-32963

**ROUSE, W. B.**
Human problem solving in fault diagnosis tasks
[AD-A167397] p 434 N86-32104

**ROWE, J. E.**
USSR Space Life Sciences Digest, issue 7
[NASA-CR-3922(08)] p 416 N86-32083

**ROZHKOV, V. P.**
Spatial organization of components of the visual evoked potentials and the sensorimotor reaction efficiency
p 419 A86-49264

**RUVINOVA, L. G.**
Functional state of the pancreas under conditions of prolonged bed rest p 421 A86-49271

**RUZIUS, M. H. B.**
Auditory versus visual selective-attention tasks
[IZF-1985-19] p 427 N86-32100

## S

**SANDERS, D. C.**
Inhalation toxicology. Part 6: Evaluation of the relative toxicity of thermal decomposition products from 9 aircraft panel materials
[AD-A168250] p 424 N86-32958

**SANES, J. N.**
Peripheral nerve injury in developing rats reorganizes motor cortex
[AD-A168019] p 417 N86-32952

**SATAKE, H.**
Effects of -Gz centrifugal acceleration upon cardiac output of hamster p 415 A86-50290

**SAXE, C.**
A simulation study of the effects of sleep deprivation, time of watch and length of time on watch on watchstanding effectiveness
[AD-A167729] p 424 N86-32956

**SAXTON, J. L.**
Growth and development of rhesus monkeys exposed to ELF (Extremely Low Frequency) electric and magnetic fields during the first 54 months of life
[AD-A168733] p 417 N86-32953

**SCHMIDT, D. K.**
Optimal cooperative control synthesis of active displays p 441 N86-33006
Modified superposition: A simple time series approach to closed-loop manual controller identification
p 442 N86-33009
Closed-loop, pilot/vehicle analysis of the approach and landing task p 442 N86-33013

**SCHUETTE, M.**
Techniques of asking questions in the evaluation of man-machine systems p 433 A86-47774

**SEARLE, R. J.**
New developments in on board oxygen generators
p 430 A86-47740

**SELIATSKAIA, V. G.**
The mechanism of the adaptogenic effect of tocopherol in prolonged cold exposure p 414 A86-49367

**SELLEN, A. J.**
At least some errors are randomly generated (Freud was wrong) p 438 N86-32989

**SELTSOVSKII, P. P.**
EEG correlates in the process of forming driving skills
p 421 A86-49273

**SENDERS, J. W.**
At least some errors are randomly generated (Freud was wrong) p 438 N86-32989

**SEREDENKO, M. M.**
External respiration, gas exchange, and blood oxygen parameters in acute methemoglobinemia
[DRIC-T-7663] p 415 N86-32082

**SERFATY, D.**
An experimental paradigm for team decision processes p 440 N86-33000

**SERGIENKO, N. G.**
The activity of cholinesterase and norepinephrine after laser irradiation of acupuncture points
p 414 A86-49921

**SEXTON, J. A.**
Effect of hypocapnia on ventral medullary blood flow and pH during hypoxia in cats p 413 A86-47869

**SHARKEY, T. D.**
Gas exchange characteristics of leaves as indicators of the basic limitations to the rate of photosynthesis
[DE86-009632] p 416 N86-32085

**SHERIDAN, T. B.**
The impact of physical and mental tasks on pilot mental workoad p 437 N86-32982

**SHEWCHENKO, N.**
The development of two prototype facial protection systems for high performance aircrew helmets
p 430 A86-47739

**SHIVELY, R. J.**
The effects of stimulus modality and task integrality: Predicting dual-task performance and workload from single-task levels p 436 N86-32981

**SHMELEVA, A. M.**
Possibility of optimizing respiratory activity by means of biocontrol p 420 A86-49266

**SHORIN, IU. P.**
The mechanism of the adaptogenic effect of tocopherol in prolonged cold exposure p 414 A86-49367

**SIDORYAK, N. G.**
External respiration, gas exchange, and blood oxygen parameters in acute methemoglobinemia
[DRIC-T-7663] p 415 N86-32082

**SILVERSTEIN, L. D.**
The development and evaluation of color systems for airborne applications: Fundamental visual, perceptual and display systems considerations
[AD-A168563] p 443 N86-33020

**SIRENKO, S. P.**
Dynamics of the cupula in the semicircular canal of the vestibular analyzer p 421 A86-49339

**SLIUSAR, I. B.**
The effect of centedrin on the work capacity of operators p 426 A86-49371

**SLIWA, N. O.**
Design for a goal-oriented telerobotic system
[AIAA PAPER 86-2090] p 429 A86-47440

**SMIRNOV, K. V.**
Functional state of the pancreas under conditions of prolonged bed rest p 421 A86-49271
**SPAUL, W. A.**
Effect of hydration on some orthostatic and haematological responses to head-up tilt p 419 A86-49225
**SREETHARAN, M.**
User interface description of a gas turbine control system
[ASME PAPER 86-GT-296] p 433 A86-48309
**SRINIVASAN, R.**
An analysis of estimation of pulmonary blood flow by the single-breath method p 413 A86-47872
**STAUNTON, B.**
On-orbit manipulators - Sensory and control approaches
[AIAA PAPER 86-2185] p 429 A86-47467
**STAVELAND, L.**
Memory and subjective workload assessment p 437 N86-32983
**STEFFLER, J. C.**
Tactical Life Support System (TLSS) aircrew integrated garment p 431 A86-47746
**STEIN, W.**
Evaluation of man-machine systems - Introduction and overview p 432 A86-47767
**STEPHENSON, L. A.**
Effect of nerve block on response of forearm blood flow to local temperature p 418 A86-47873
**STEVENSON, G. F.**
New developments in on board oxygen generators p 430 A86-47740
**STOECKENIUS, W.**
Photoactive pigments in halobacteria from the Gavish Sabkha p 415 A86-49998
The rhodopsin-like pigments of halobacteria - Light-energy and signal transducers in an archaebacterium p 415 A86-50271
**STOLP, B. W.**
Pulmonary gas exchange in humans exercising at sea level and simulated altitude p 419 A86-47874
**STORCH, N. A.**
Striving for natural usage
[DE86-009402] p 435 N86-32105
**STREUFERT, S.**
Data collection via a quasi-experimental simulation technology. Part 1: Multiple measurement of performance excellence in complex and uncertain managerial tasks
[AD-A167949] p 428 N86-32969
**STROHAVER, R. A.**
In vivo dermal absorption method and system for laboratory animals
[AD-D012325] p 417 N86-32951
**STRUCHKOVA, T. IA.**
Functional state of the pancreas under conditions of prolonged bed rest p 421 A86-49271
**SULZMAN, F. M.**
Evaluation of the need for a large primate research facility in space
[NASA-CR-179661] p 444 N86-32111
**SURKINA, I. D.**
Changes in immunity under stress p 420 A86-49267

## T

**TASK, H. L.**
Variable contrast direct read-out vision tester
[AD-D012273] p 423 N86-32955
Night vision compatible illumination for vehicle crewmember workspace
[AD-D012339] p 443 N86-33018
**TEDOR, J. B.**
Molecular sieve oxygen generation system (MSOGS) onboard the B-1B bomber p 430 A86-47737
Development of a portable oxygen system analyzer p 430 A86-47742
Test and evaluation of the B-1B molecular sieve oxygen generating system p 431 A86-47751
**TEETER, R.**
USSR Space Life Sciences Digest, issue 7
[NASA-CR-3922(08)] p 416 N86-32083
**TERENTYEV, V. G.**
Special features of surgical intervention under conditions of weightlessness
[AD-A167916] p 423 N86-32092
**THACKRAY, R. I.**
Complex monitoring performance and the coronary-prone type A behavior pattern
[AD-A168240] p 428 N86-32971
**THIELE, W.**
Effects of hypodynamia and neuroemotional stress on the performance of circulatory and respiratory systems during muscular work p 422 A86-49919
**THIMLING, K. R.**
In vivo dermal absorption method and system for laboratory animals
[AD-D012325] p 417 N86-32951
**TIBBITTS, T. W.**
Controlled environment life support system: Growth studies with potatoes
[NASA-CR-177400] p 434 N86-32101
**TOLMACHEVA, M. IA.**
Functional state of the pancreas under conditions of prolonged bed rest p 421 A86-49271
**TOMCHUK, P. M.**
Proton transfer in bacteriorhodopsin p 413 A86-49345
Proton ejection from bacteriorhodopsin p 413 A86-49346
Proton injection into bacteriorhodopsin p 414 A86-49347
The retinal cycle in bacteriorhodopsin p 414 A86-49348
**TOMLINSON, G. A.**
Halobacterium denitrificans sp. nov. - An extremely halophilic denitrifying bacterium p 414 A86-49524
**TORRE-BUENO, J. R.**
Pulmonary gas exchange in humans exercising at sea level and simulated altitude p 419 A86-47874
**TOUCHSTONE, R. M.**
Complex monitoring performance and the coronary-prone type A behavior pattern
[AD-A168240] p 428 N86-32971
**TRAD, L. A.**
Altitude acclimatization attentuates plasma ammonia during submaximal exercise
[AD-A168630] p 425 N86-32962
**TSANG, P. S.**
Evaluation of 2 cognitive abilities tests in a dual-task environment p 438 N86-32988
**TYLER, J. G.**
On marching to two different drummers - Perceptual aspects of the difficulties p 426 A86-49870

## U

**UCKERMANN, R.**
Investigating the ocular fixation of targets as an anthropotechnical research method in man-machine systems p 433 A86-47772
**UDALOVA, S. V.**
The use of a constitutional approach in the evaluation of health status p 420 A86-49270
**URANO, H.**
Effects of -Gz centrifugal acceleration upon cardiac output of hamster p 415 A86-50290

## V

**VAN PATTEN, R. E.**
Current research on advanced concept anti-G suits p 431 A86-47747
**VANAALST, T. J. P.**
A model of the transient part of the spatio-temporal perception, containing a two-dimensional long fiber
[ETN-86-97540] p 426 N86-32966
**VANDEGRAAFF, R. C.**
Control loops with human operators in space operations. Part 1: Human engineering analysis, synthesis and evaluation techniques
[NLR-TR-84116-L-PT-1] p 435 N86-32107
**VANDENDRIESSCHE, J.**
Use of artificial intelligence and psychology in the analysis of command and control
[STC-TM-749] p 427 N86-32095
**VANSWIETEN, C. M.**
Control loops with human operators in space operations. Part 2: Robotics operations and manual control experiment
[NLR-TR-84116-L-PT-2] p 444 N86-33024
**VANWOERKOM, P. T. L. M.**
Control loops with human operators in space operations. Part 3: Rendezvous and docking operations and model analysis of performance with human-in-the-loop
[NLR-TR-84116-L-PT-3] p 435 N86-32108
**VASILEV, IA. A.**
Spectral-correlation characteristics of EEG in the course of short-term memory tests. I - A study of spectral-correlation parameters of the potentials in the human neocortex during correct short-term memorizing p 419 A86-49263
**VERRI, A.**
Perspective projection invariants
[AD-A167783] p 428 N86-32968
**VIDULICH, M. A.**
The effects of stimulus modality and task integrality: Predicting dual-task performance and workload from single-task levels p 436 N86-32981
Evaluation of 2 cognitive abilities tests in a dual-task environment p 438 N86-32988
**VOLKWERTS, E. R.**
Zopiclone's residual effect upon actual driving performance versus those of nitrazepam and flunitrazepam
[VK-84-10] p 423 N86-32954

## W

**WAGNER, P. D.**
Pulmonary gas exchange in humans exercising at sea level and simulated altitude p 419 A86-47874
**WARD, L.**
On-orbit manipulators - Sensory and control approaches
[AIAA PAPER 86-2185] p 429 A86-47467
**WARD, S. L.**
The effects of acceleration stress on human workload and manual control p 437 N86-32984
**WARNER, J. S.**
Maximum normalized acceleration as a flying qualities parameter p 442 N86-33012
**WATANABE, S.**
Effects of -Gz centrifugal acceleration upon cardiac output of hamster p 415 A86-50290
**WEIL, J. V.**
Predictors of periodic breathing at altitude
[AD-A167947] p 424 N86-32957
**WENGER, C. B.**
Effect of nerve block on response of forearm blood flow to local temperature p 418 A86-47873
**WEST, B. J.**
Nonlinear mechanisms in physiology and pathophysiology Toward a dynamical theory of health and disease p 422 A86-49636
**WEST, J. B.**
Nocturnal periodic breathing at altitudes of 6,300 and 8,050 m p 419 A86-47875
**WEWERINKE, P. H.**
Control theoretic analysis of human operator mediated rendezvous and docking
[NLR-MP-85020-U] p 435 N86-32106
Control loops with human operators in space operations. Part 1: Human engineering analysis, synthesis and evaluation techniques
[NLR-TR-84116-L-PT-1] p 435 N86-32107
Control loops with human operators in space operations. Part 3: Rendezvous and docking operations and model analysis of performance with human-in-the-loop
[NLR-TR-84116-L-PT-3] p 435 N86-32108
Model analysis of remotely controlled rendezvous and docking with display prediction p 441 N86-33003
**WHEELER, R. M.**
Controlled environment life support system: Growth studies with potatoes
[NASA-CR-177400] p 434 N86-32101
**WHEELER, T. G.**
The startle reflex as a learning task: Apparatus and test parameters
[AD-A167958] p 428 N86-32970
**WHITE, D. P.**
Altitude acclimatization (ventilation and chemoresponsiveness) during wakefulness and sleep
[AD-A167738] p 423 N86-32091
Predictors of periodic breathing at altitude
[AD-A167947] p 424 N86-32957
**WHITE, R. P., JR.**
Development of a mechanical analog of a human spine and viscera p 418 A86-47753
**WHITE, S. A.**
Modified Petri net model sensitivity to workload manipulations p 436 N86-32979
**WHITLER, P.**
Anti-G suit protection and body position p 432 A86-47764
**WHITMAN, G. R.**
The changing face of constant wear anti-exposure protection p 431 A86-47749
**WICKENS, C. D.**
The effects of voice and manual control mode on dual task performance p 438 N86-32987
**WILL, R. W.**
Design for a goal-oriented telerobotic system
[AIAA PAPER 86-2090] p 429 A86-47440
**WILLSHIRE, K. F.**
Automation and robotics for Space Station in the twenty-first century
[AIAA PAPER 86-2300] p 434 A86-49552

**WOHNS, R. N.**
Effects of high altitude on neurological and pulmonary function: The effect of high altitude on visual evoked potentials in humans on Mt. Everest
[AD-A168335] p 424 N86-32959
**WORMSER, L. W.**
The changing face of constant wear anti-exposure protection p 431 A86-47749

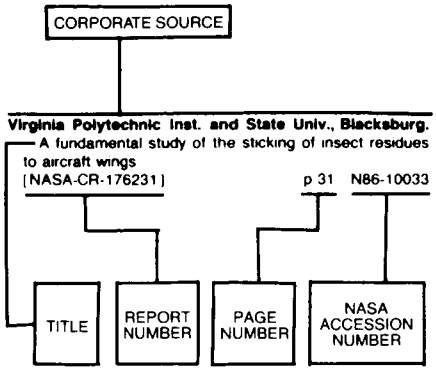
## Y

**YAROSHENKO, G. L.**
Special features of surgical intervention under conditions of weightlessness
*[AD-A167916]* *p 423* *N86-32092*
**YEH, Y. Y.**
Memory and subjective workload assessment
p 437 N86-32983
**YOON, W. C.**
Aiding the operator during novel fault diagnosis
p 426 A86-49633
**YOUNG, P. M.**
*Altitude acclimatization attentuates plasma ammonia* during submaximal exercise
[AD-A168630] p 425 N86-32962
**YUILLE, A.**
Perspective projection invariants
[AD-A167783] p 428 N86-32968

## Z

**ZALESKI, M.**
Hitts Law? A test of the relationship between information load and movement precision p 440 N86-32998
**ZENYUH, J.**
The effects of voice and manual control mode on dual task performance p 438 N86-32987

## Typical Corporate Source Index Listing




Listings in this index are arranged alphabetically by corporate source. The title of the document is used to provide a brief description of the subject matter. The page number and the accession number are included in each entry to assist the user in locating the abstract in the abstract section. If applicable, a report number is also included as an aid in identifying the document.


## A

**Aerospace Medical Div., Brooks AFB, Tex.**
Air Force technical objective document, Aerospace Medical Division, FY 1987
[AD-A167422] p 423 N86-32090

**Aerospace Medical Research Labs., Wright-Patterson AFB, Ohio.**
Analytical comparison of transient and steady state visual evoked cortical potentials p 436 N86-32978
Active controllers and the time duration to learn a task p 439 N86-32994
A collation of United States Air Force anthropometry
[AD-A168485] p 443 N86-33019

**Air Force Inst. of Tech., Wright-Patterson AFB, Ohio.**
Absolute judgment versus absolute magnitude estimation to convey information through symbol magnitude changes in CRT displays
[AD-A167059] p 434 N86-32103

**Air Force Systems Command, Wright-Patterson AFB, Ohio.**
Special features of surgical intervention under conditions of weightlessness
[AD-A167916] p 423 N86-32092

**Air Line Pilots Association, International, Denison, Tex.**
Pilot interface with fly by wire control systems p 438 N86-32990

**Anacapa Sciences, Inc., Fort Rucker, Ala.**
Human factors research in aircrew performance and training
[AD-A167740] p 427 N86-32967

**Anco Engineers, Inc., Culver City, Calif.**
Radiographic determination of mass of inertial tensors of anatomical segments
[AD-A168581] p 425 N86-32961

**Army Research Inst. of Environmental Medicine, Natick, Mass.**
Altitude acclimatization (ventilation and chemoresponsiveness) during wakefulness and sleep
[AD-A167738] p 423 N86-32091
Predictors of periodic breathing at altitude
[AD-A167947] p 424 N86-32957
Altitude acclimatization attentuates plasma ammonia during submaximal exercise
[AD-A168630] p 425 N86-32962
Effect of dexamethasone on symptoms of acute mountain sickness at Pikes Peak, Colorado (4300m)
[AD-A168662] p 425 N86-32963

**Association of American Ultima Thule, Issaquah, Wash.**
Effects of high altitude on neurological and pulmonary function: The effect of high altitude on visual evoked potentials in humans on Mt. Everest
[AD-A168335] p 424 N86-32959

## B

**Baylor Univ., Houston, Tex.**
Development of otoconia in the embryonic chick (Gallus domesticus) p 414 A86-49871

**Bolt, Beranek, and Newman, Inc., Cambridge, Mass.**
Descriptive Linear modeling of steady-state visual evoked response p 436 N86-32977
Some computational techniques for estimating human operator describing functions p 441 N86-33007

**Brookhaven National Lab., Upton, N. Y.**
Proposal for a new tomographic device providing information on the chemical properties of a body section
[DE86-010547] p 425 N86-32964

**Brown Univ., Providence, R. I.**
Peripheral nerve injury in developing rats reorganizes motor cortex
[AD-A168019] p 417 N86-32952

## C

**CAE Electronics Ltd., St. Laurent (Quebec).**
Flight test of a displacement sidearm controller p 439 N86-32992

**California State Univ., Hayward.**
On marching to two different drummers - Perceptual aspects of the difficulties p 426 A86-49870
Hesitation in tracking induced by a concurrent manual task p 439 N86-32995

**California Univ., Davis.**
A model for the human's use of visual field cues in nap-of-the-Earth flight p 441 N86-33004

**California Univ., La Jolla.**
Nonlinear mechanisms in physiology and pathophysiology Toward a dynamical theory of health and disease p 422 A86-49636

**California Univ., Los Angeles.**
Modified Petri net model sensitivity to workload manipulations p 436 N86-32979
Knowledge-based load leveling and task allocation in human-machine systems p 437 N86-32985
The effects of stress on attentional resources p 437 N86-32986

**California Univ., San Francisco.**
The rhodopsin-like pigments of halobacteria - Light-energy and signal transducers in an archaebacterium p 415 A86-50271

**Colorado Univ., Boulder.**
Predictors of periodic breathing at altitude
[AD-A167947] p 424 N86-32957

**Connecticut Univ., Storrs.**
An experimental paradigm for team decision processes p 440 N86-33000

## D

**Defence Research Information Centre, Orpington (England).**
External respiration, gas exchange, and blood oxygen parameters in acute methemoglobinemia
[DRIC-T-7663] p 415 N86-32082

**Department of the Air Force, Washington, D.C.**
In vivo dermal absorption method and system for laboratory animals
[AD-D012325] p 417 N86-32951
Variable contrast direct read-out vision tester
[AD-D012273] p 423 N86-32955
Night vision compatible illumination for vehicle crewmember workspace
[AD-D012339] p 443 N86-33018

**Department of the Navy, Washington, D. C.**
Automated anthropometric data measurement system
[AD-D012299] p 443 N86-33017

**Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany).**
Investigation of pilot behavior within the scope of a training program for handling qualities rating in a ground simulator
[DFVLR-MITT-86-01] p 429 N86-32975

## E

**Essex Corp., Alexandria, Va.**
Human Factors Review Plan
[DE86-010561] p 444 N86-33023

**European Space Agency, Paris (France).**
Influence of gravity on structure and behavior of Paramecium caudatum
[ESA-TT-963] p 416 N86-32087
Speed of work and error rate: Analyses of individual differences in a choice reaction series with a cognitive component
[ESA-TT-944] p 427 N86-32099

## F

**Federal Aviation Administration, Washington, D.C.**
Inhalation toxicology. Part 6: Evaluation of the relative toxicity of thermal decomposition products from 9 aircraft panel materials
[AD-A168250] p 424 N86-32958
Complex monitoring performance and the coronary-prone type A behavior pattern
[AD-A168240] p 428 N86-32971

**Florida State Univ., Tallahassee.**
Guard cell biochemistry: Response to environmental stimuli causing changes in gas exchange
[DE86-010287] p 416 N86-32086

## G

**Georgia Inst. of Tech., Atlanta.**
Aiding the operator during novel fault diagnosis p 426 A86-49633
Issues in rule identification and logical induction p 434 A86-49634
Human problem solving in fault diagnosis tasks
[AD-A167397] p 434 N86-32104

**Graz Univ. (Austria).**
Method of high-precision microsampled blood and plasma mass densitometry p 419 A86-49250
Fluid and protein shifts after postural changes in humans p 421 A86-49523

**Groningen Rijksuniversiteit (Netherlands).**
Zopiclone's residual effect upon actual driving performance versus those of nitrazepam and flunitrazepam
[VK-84-10] p 423 N86-32954

## H

**Hershey (Milton S.) Medical Center, Hershey, Pa.**
Predictors of periodic breathing at altitude
[AD-A167947] p 424 N86-32957
Data collection via a quasi-experimental simulation technology. Part 1: Multiple measurement of performance excellence in complex and uncertain managerial tasks
[AD-A167949] p 428 N86-32969

**Human Engineering Labs., Aberdeen Proving Ground, Md.**
Anthropometric considerations for a 4-axis side-arm flight controller p 439 N86-32993


SOURCE

## I

**Idaho Univ., Moscow.**
The effects of acceleration stress on human workload and manual control p 437 N86-32984
**Illinois Univ., Savoy.**
The effects of voice and manual control mode on dual task performance p 438 N86-32987
**Illinois Univ., Urbana.**
The role of impulse parameters in force variability p 439 N86-32997
**Institut fuer Flugmechanik, Brunswick (West Germany).**
A flight test method for pilot/aircraft analysis p 442 N86-33011
**Institute for Perception RVO-TNO, Soesterberg (Netherlands).**
Auditory versus visual selective-attention tasks [IZF-1985-19] p 427 N86-32100

## J

**Jet Propulsion Lab., California Inst. of Tech., Pasadena.**
Automation and robotics for Space Station in the twenty-first century [AIAA PAPER 86-2300] p 434 A86-49552
Force/torque display for space teleoperation control experiments and evaluation p 440 N86-33002
**Johns Hopkins Univ., Baltimore, Md.**
Development of intuitive theories of motion - Curvilinear motion in the absence of external forces p 426 A86-49521

## K

**Kansas State Univ., Manhattan.**
Improved flexibility of an EVA glove p 433 A86-48713

## L

**La Jolla Inst., Calif.**
Nonlinear mechanisms in physiology and pathophysiology Toward a dynamical theory of health and disease p 422 A86-49636
**Lawrence Livermore National Lab., Calif.**
Striving for natural usage [DE86-009402] p 435 N86-32105
Human Factors Review Plan [DE86-010561] p 444 N86-33023
**London Univ. (England).**
Effect of inactivity and passive stretch on protein turnover in phasic and postural rat muscles p 413 A86-47871

## M

**Management and Technical Services Co., Houston, Tex.**
An analysis of estimation of pulmonary blood flow by the single-breath method p 413 A86-47872
**Management and Technical Services Co., Washington, D.C.**
USSR Space Life Sciences Digest, issue 7 [NASA-CR-3922(08)] p 416 N86-32083
**Massachusetts Inst. of Tech., Cambridge.**
Perspective projection invariants [AD-A167783] p 428 N86-32968
The impact of physical and mental tasks on pilot mental workoad p 437 N86-32982
**Michigan Univ., Ann Arbor.**
Development of intuitive theories of motion - Curvilinear motion in the absence of external forces p 426 A86-49521

## N

**National Aeronautics and Space Administration, Washington, D.C.**
Aerospace medicine and biology: A continuing bibliography with indexes (supplement 288) [NASA-SP-7011(288)] p 422 N86-32088
NASA Facts: Space Shuttle food systems [NF-150/1-86] p 434 N86-32102
**National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.**
Effect of hydration on some orthostatic and haematological responses to head-up tilt p 419 A86-49225
Method of high-precision microsampled blood and plasma mass densitometry p 419 A86-49250
Development of intuitive theories of motion - Curvilinear motion in the absence of external forces p 426 A86-49521
Fluid and protein shifts after postural changes in humans p 421 A86-49523
Halobacterium denitrificans sp. nov. - An extremely halophilic denitrifying bacterium p 414 A86-49524
Structural correlates of aging in Drosophila - Relevance to the cell differentiation, rate-of-living and free radical theories of aging p 415 A86-49999
NASA Workshop on Animal Gravity-Sensing Systems [NASA-TM-88249] p 417 N86-32950
Twenty-First Annual Conference on Manual Control [NASA-CP-2428] p 436 N86-32976
Levels of Information Processing in a Fitts law task (LIPFitts) p 436 N86-32980
The effects of stimulus modality and task integrality: Predicting dual-task performance and workload from single-task levels p 436 N86-32981
Memory and subjective workload assessment p 437 N86-32983
Evaluation of 2 cognitive abilities tests in a dual-task environment p 438 N86-32988
Aircrew coordination and decisionmaking: Peer ratings of video tapes made during a full mission simulation p 440 N86-32999
Virtual space and 2-dimensional effects in perspective displays p 441 N86-33005
**National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.**
Flight training for Space Shuttle missions p 427 A86-50283
**National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.**
Design for a goal-oriented telerobotic system [AIAA PAPER 86-2090] p 429 A86-47440
Automation and robotics for Space Station in the twenty-first century [AIAA PAPER 86-2300] p 434 A86-49552
**National Aerospace Lab., Amsterdam (Netherlands).**
Control theoretic analysis of human operator mediated rendezvous and docking [NLR-MP-85020-U] p 435 N86-32106
Control loops with human operators in space operations. Part 1: Human engineering analysis, synthesis and evaluation techniques [NLR-TR-84116-L-PT-1] p 435 N86-32107
Control loops with human operators in space operations. Part 3: Rendezvous and docking operations and model analysis of performance with human-in-the-loop [NLR-TR-84116-L-PT-3] p 435 N86-32108
Control loops with human operators in space operations. Part 4: Research requirements for human-in-the-loop space teleoperator development [NLR-TR-84116-L-PT-4] p 435 N86-32109
Control loops with human operators in space operations. Part 5: Executive summary [NLR-TR-84116-L-PT-5] p 435 N86-32110
Model analysis of remotely controlled rendezvous and docking with display prediction p 441 N86-33003
Control loops with human operators in space operations. Part 2: Robotics operations and manual control experiment [NLR-TR-84116-L-PT-2] p 444 N86-33024
**National Aerospace Medical Centre, Soesterberg (Netherlands).**
Activities report on physical and psychological health of flying personnel [ETN-86-97385] p 423 N86-32093
Activities report on physical and psychological health of flying personnel [ETN-86-97386] p 423 N86-32094
**National Maritime Research Center, Kings Point, N. Y.**
A simulation study of the effects of sleep deprivation, time of watch and length of time on watch on watchstanding effectiveness [AD-A167729] p 424 N86-32956
**Naval Aerospace Medical Research Lab., Pensacola, Fla.**
Growth and development of rhesus monkeys exposed to ELF (Extremely Low Frequency) electric and magnetic fields during the first 54 months of life [AD-A168733] p 417 N86-32953
A comparison of the specific absorption rate in a homogeneous man model and a man model containing realistic model bones [AD-A168547] p 424 N86-32960
Multitask performance: Predicting success in Naval Aviation primary flight training [AD-A168246] p 428 N86-32972
**Naval Air Development Center, Warminster, Pa.**
The development and evaluation of color systems for airborne applications: Fundamental visual, perceptual and display systems considerations [AD-A168563] p 443 N86-33020
**Naval Coastal Systems Center, Panama City, Fla.**
Elementary design guidelines for CO2 scrubbing with LiOH, technical manual [AD-A168850] p 444 N86-33022
**Nevada Univ., Reno.**
Gas exchange characteristics of leaves as indicators of the basic limitations to the rate of photosynthesis [DE86-009632] p 416 N86-32085
**Northrop Corp., Hawthorne, Calif.**
Maximum normalized acceleration as a flying qualities parameter p 442 N86-33012

## O

**Ohio State Univ., Columbus.**
On marching to two different drummers - Perceptual aspects of the difficulties p 426 A86-49870
Progression-regression effects in tracking repeated patterns p 439 N86-32996
Investigation of crew performance in a multi-vehicle supervisory control task p 440 N86-33001

## P

**Perceptronics, Inc., Woodland Hills, Calif.**
Operator alertness/workload assessment using stochastic model-based analysis of myoelectric signals [AD-A168567] p 428 N86-32973
Operator alertness/workload assessment using stochastic model-based analysis of myoelectric signals [AD-A168568] p 429 N86-32974
**Purdue Univ., West Lafayette, Ind.**
Optimal cooperative control synthesis of active displays p 441 N86-33006
Modified superposition: A simple time series approach to closed-loop manual controller identification p 442 N86-33009
Closed-loop, pilot/vehicle analysis of the approach and landing task p 442 N86-33013

## Q

**Queens Univ., Belfast (Northern Ireland).**
Effect of inactivity and passive stretch on protein turnover in phasic and postural rat muscles p 413 A86-47871

## R

**Rochester Inst. of Tech., N. Y.**
Speech analysis based on a model of the auditory system [AD-A167426] p 427 N86-32098
**Royal Netherlands Aircraft Factories Fokker, Amsterdam.**
Control loops with human operators in space operations. Part 2: Robotics operations and manual control experiment [NLR-TR-84116-L-PT-2] p 444 N86-33024

## S

**Santa Clara Univ., Calif.**
Halobacterium denitrificans sp. nov. - An extremely halophilic denitrifying bacterium p 414 A86-49524
**School of Aerospace Medicine, Brooks AFB, Tex.**
Evaluation of 9.5 PSIA as a suit pressure for prolonged extravehicular activity p 417 A86-47741
The relationship of intravascular bubbles to bends at altitude p 418 A86-47765
The startle reflex as a learning task: Apparatus and test parameters [AD-A167958] p 428 N86-32970
Effect of oxygen flow on passenger face mask performance [AD-A168832] p 443 N86-33021
**Shape Technical Center, The Hague (Netherlands).**
Use of artificial intelligence and psychology in the analysis of command and control [STC-TM-749] p 427 N86-32095
The psychology of decision making p 427 N86-32096
Artificial intelligence and the Rule Oriented System Simulation (ROSS) language p 427 N86-32097
**Southampton Univ. (England).**
A design guide for visual displays and manual tasks in vibration environments. Part 1: Visual displays [ISVR-TR-133-PT-1] p 442 N86-33014
A design guide for visual displays and manual tasks in vibration environments. Part 2: Manual tasks [ISVR-TR-134] p 443 N86-33015

**Stanford Univ., Calif.**
Control of a free-flying robot manipulator system
[NASA-CR-179717] p 443 N86-33016
**State Univ. of New York, Binghamton.**
Evaluation of the need for a large primate research facility in space
[NASA-CR-179661] p 444 N86-32111
**Systems Technology, Inc., Hawthorne, Calif.**
Investigation of limb-sidestick dynamic interaction with roll control p 438 N86-32991
*Manual control of unstable systems*
p 441 N86-33008
Comparison of the STI NIPIP tracking dynamics identification with the on-line Fourier analyzer DFA results including a time varying case p 442 N86-33010

## T

**Technion - Israel Inst. of Tech., Haifa.**
A 24-hour structure of vigilance under prolonged sleep deprivation: Relationship with performance
[AD-A167399] p 422 N86-32089
**Technische Hogeschool, Eindhoven (Netherlands).**
Implementation of models for the transient division system of spatio-temporal visual perception
[ETN-86-97533] p 425 N86-32965
A model of the transient part of the spatio-temporal perception, containing a two-dimensional long fiber
[ETN-86-97540] p 426 N86-32966
**Technology, Inc., San Antonio, Tex.**
Evaluation of 9.5 PSIA as a suit pressure for prolonged extravehicular activity p 417 A86-47741
The relationship of intravascular bubbles to bends at altitude p 418 A86-47765
**Texas Univ., Dallas.**
A chinchilla restraint system
[AD-A167408] p 416 N86-32084
**Toronto Univ. (Ontario).**
At least some errors are randomly generated (Freud was wrong) p 438 N86-32989
Hitts Law? A test of the relationship between information load and movement precision p 440 N86-32998

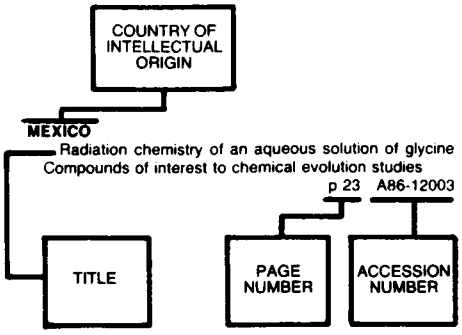
## V

**Veterans Administration Hospital, San Diego, Calif.**
Nonlinear mechanisms in physiology and pathophysiology Toward a dynamical theory of health and disease p 422 A86-49636
**Virginia Univ., Charlottesville.**
Development of intuitive theories of motion - Curvilinear motion in the absence of external forces
p 426 A86-49521

## W

**Wisconsin Univ., Madison.**
Controlled environment life support system: Growth studies with potatoes
[NASA-CR-177400] p 434 N86-32101

## Typical Foreign Technology Index Listing




Listings in this index are arranged alphabetically by country of intellectual origin. The title of the document is used to provide a brief description of the subject matter. The page number and the accession number are included in each entry to assist the user in locating the citation in the abstract section.

## A

**AUSTRIA**

Fluid and protein shifts after postural changes in humans p 421 A86-49523

## C

**CANADA**

The development of two prototype facial protection systems for high performance aircrew helmets p 430 A86-47739

Tactical Life Support System (TLSS) aircrew integrated garment p 431 A86-47746

## F

**FRANCE**

Effect of physical training in humans on the response of isolated fat cells to epinephrine p 418 A86-47868

Development of a hierarchical multiprocessor control for a polyarticulated mechanical structure used to study human operators subjected to vibrations p 433 A86-48553

Speed of work and error rate: Analyses of individual differences in a choice reaction series with a cognitive component
[ESA-TT-944] p 427 N86-32099

## G

**GERMANY,FEDERAL REPUBLIC OF**

Evaluation of man-machine systems: Methods and problems; Symposium, November 14, 15, 1985, Cologne, West Germany, Reports
[DGLR-BERICHT 85-04] p 432 A86-47766

Evaluation of man-machine systems - Introduction and overview p 432 A86-47767

Determination of the load and stress on a cockpit crew during flight using tasking networks and the SAINT simulation language p 432 A86-47770

Application of the method of problem taxonomy to the simulation of human service reliability in the manual steering of aircraft
[MBB-LKE-301/S/PUB/216] p 432 A86-47771

Investigating the ocular fixation of targets as an anthropotechnical research method in man-machine systems p 433 A86-47772

A basic concept for evaluating man-machine systems p 433 A86-47773

Techniques of asking questions in the evaluation of man-machine systems p 433 A86-47774

A measure of usability p 433 A86-47775

Photoactive pigments in halobacteria from the Gavish Sabkha p 415 A86-49998

Influence of gravity on structure and behavior of Paramecium caudatum
[ESA-TT-963] p 416 N86-32087

Investigation of pilot behavior within the scope of a training program for handling qualities rating in a ground simulator
[DFVLR-MITT-86-01] p 429 N86-32975

## J

**JAPAN**

Biochemical responses of Xenopus Laevis muscles to changes in environment. I. - Comparison to Rana Catesbeiana and exposure to gravic environment p 415 A86-50288

Biochemical responses of Xenopus laevis muscles to changes in environment. II - Responses to gravity and pressure p 415 A86-50289

Effects of -Gz centrifugal acceleration upon cardiac output of hamster p 415 A86-50290

## N

**NETHERLANDS**

Activities report on physical and psychological health of flying personnel
[ETN-86-97385] p 423 N86-32093

Activities report on physical and psychological health of flying personnel
[ETN-86-97386] p 423 N86-32094

Use of artificial intelligence and psychology in the analysis of command and control
[STC-TM-749] p 427 N86-32095

The psychology of decision making p 427 N86-32096

Artificial intelligence and the Rule Oriented System Simulation (ROSS) language p 427 N86-32097

Auditory versus visual selective-attention tasks
[IZF-1985-19] p 427 N86-32100

Control theoretic analysis of human operator mediated rendezvous and docking
[NLR-MP-85020-U] p 435 N86-32106

Control loops with human operators in space operations. Part 1: Human engineering analysis, synthesis and evaluation techniques
[NLR-TR-84116-L-PT-1] p 435 N86-32107

Control loops with human operators in space operations. Part 3: Rendezvous and docking operations and model analysis of performance with human-in-the-loop
[NLR-TR-84116-L-PT-3] p 435 N86-32108

Control loops with human operators in space operations. Part 4: Research requirements for human-in-the-loop space teleoperator development
[NLR-TR-84116-L-PT-4] p 435 N86-32109

Control loops with human operators in space operations. Part 5: Executive summary
[NLR-TR-84116-L-PT-5] p 435 N86-32110

Zopiclone's residual effect upon actual driving performance versus those of nitrazepam and flunitrazepam
[VK-84-10] p 423 N86-32954

Implementation of models for the transient division system of spatio-temporal visual perception
[ETN-86-97533] p 425 N86-32965

A model of the transient part of the spatio-temporal perception, containing a two-dimensional long fiber
[ETN-86-97540] p 426 N86-32966

Control loops with human operators in space operations. Part 2: Robotics operations and manual control experiment
[NLR-TR-84116-L-PT-2] p 444 N86-33024

## U

**U.S.S.R.**

The effect of noradrenaline on oxidation metabolism in cold-adapted golden hamsters p 413 A86-49155

Spectral-correlation characteristics of EEG in the course of short-term memory tests. I - A study of spectral-correlation parameters of the potentials in the human neocortex during correct short-term memorizing p 419 A86-49263

Spatial organization of components of the visual evoked potentials and the sensorimotor reaction efficiency p 419 A86-49264

The use of cardiac-rhythm statistical characteristics in evaluating mental work capacity p 420 A86-49265

Possibility of optimizing respiratory activity by means of biocontrol p 420 A86-49266

Changes in immunity under stress p 420 A86-49267

A quick method for evaluating operators' work capacity p 420 A86-49268

Seasonal and circadian rhythms in androgen excretion in the extremely continental climate of Trans-Baikal and the BAM region among groups of local nonnative population p 420 A86-49269

The use of a constitutional approach in the evaluation of health status p 420 A86-49270

Functional state of the pancreas under conditions of prolonged bed rest p 421 A86-49271

The frequency of sister chromatid exchanges in blood cells under prolonged hypokinesia p 421 A86-49272

EEG correlates in the process of forming driving skills p 421 A86-49273

Dynamics of the cupula in the semicircular canal of the vestibular analyzer p 421 A86-49339

Proton transfer in bacteriorhodopsin p 413 A86-49345

Proton ejection from bacteriorhodopsin p 413 A86-49346

Proton injection into bacteriorhodopsin p 414 A86-49347

The retinal cycle in bacteriorhodopsin p 414 A86-49348

The mechanism of the adaptogenic effect of tocopherol in prolonged cold exposure p 414 A86-49367

Changes in the blood coagulation system of rabbits under conditions of acute hypoxia and some methods of its correction p 414 A86-49368

Ergometric examination of the cardiovascular system in flight personnel p 421 A86-49370

The effect of centedrin on the work capacity of operators p 426 A86-49371

Effects of hypodynamia and neuroemotional stress on the performance of circulatory and respiratory systems during muscular work p 422 A86-49919

Correlational rhythmography applied to persons of different age under functional loads p 422 A86-49920

The activity of cholinesterase and norepinephrine after laser irradiation of acupuncture points p 414 A86-49921

On the interrelationship between different ranges of bioelectric activity of the human brain p 422 A86-49975

External respiration, gas exchange, and blood oxygen parameters in acute methemoglobinemia
[DRIC-T-7663] p 415 N86-32082

Special features of surgical intervention under conditions of weightlessness
[AD-A167916] p 423 N86-32092

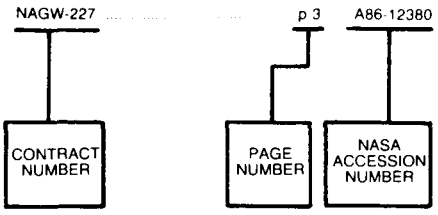
**UNITED KINGDOM**

New developments in on board oxygen generators p 430 A86-47740

FOREIGN

A design guide for visual displays and manual tasks in vibration environments. Part 1: Visual displays
[ISVR-TR-133-PT-1] p 442 N86-33014
A design guide for visual displays and manual tasks in vibration environments. Part 2: Manual tasks
[ISVR-TR-134] p 443 N86-33015

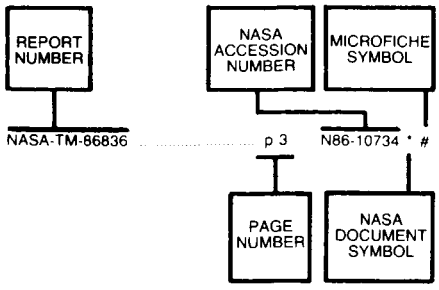
### Typical Contract Number Index Listing




Listings in this index are arranged alpha-numerically by contract number. Under each contract number, the accession numbers denoting documents that have been produced as a result of research done under that contract are arranged in ascending order with the AIAA accession numbers appearing first. The accession number denotes the number by which the citation is identified in the abstract section. Preceding the accession number is the page number on which the citation may be found.


AF-AFOSR-2312-V2 ..... p 436 N86-32978
A83/K/045 ..... p 427 N86-32100
DA PROJ. 2Q1-61102-B-74-D ..... p 422 N86-32089
DA PROJ. 2Q1-61102-B-74-F ..... p 434 N86-32104
p 428 N86-32969
DA PROJ. 2Q2-63743-A-792 ..... p 427 N86-32967
DA PROJ. 2Q2-63743-A-793 ..... p 427 N86-32967
DA PROJ. 3E1-62777-A-879 ..... p 424 N86-32959
DA PROJ. 3M6-1102-BS-10 ..... p 416 N86-32084
DAJA45-83-C-0047 ..... p 422 N86-32089
DAMD17-80-C-0109 ..... p 416 N86-32084
DAMD17-84-G-4023 ..... p 424 N86-32959
DE-AC02-76CH-00016 ..... p 425 N86-32964
DE-AS05-81ER-10803 ..... p 416 N86-32086
DE-FG08-84ER-13234 ..... p 416 N86-32085
ESA-5594/83/NL/AN(SC) ..... p 441 N86-33003
ESA-5594/83 ..... p 435 N86-32107
p 435 N86-32108
p 435 N86-32109
p 435 N86-32110
p 444 N86-33024
FFWF PROJECT 3470 ..... p 419 A86-49250
FFWF PROJECT 4200 ..... p 419 A86-49250
p 421 A86-49523
F30602-81-C-0169 ..... p 427 N86-32098
F33615-82-C-0629 ..... p 442 N86-33010
F49620-83-C-0001 ..... p 428 N86-32973
p 429 N86-32974
MDA903-79-C-0421 ..... p 434 N86-32104
MDA903-81-C-0504 ..... p 427 N86-32967
MDA903-83-C-0106 ..... p 428 N86-32969
NAGW-429 ..... p 440 N86-32998
NAG2-123 ..... p 426 A86-49633
p 434 A86-49634
NAG2-195 ..... p 426 A86-49870
p 436 N86-32976
NAG2-228 ..... p 441 N86-33006
NAG2-232 ..... p 444 N86-32111
NAG2-272 ..... p 413 A86-47871
NAG2-342 ..... p 414 A86-49871
NASA ORDER T-82170 ..... p 417 A86-47741
p 418 A86-47765
NASW-3676 ..... p 416 N86-32083
NAS2-11454 ..... p 438 N86-32991
NAS9-15850 ..... p 413 A86-47872
NAS9-17133 ..... p 413 A86-47872
NCC2-223 ..... p 426 A86-49870
p 439 N86-32995
NCC2-301 ..... p 434 N86-32101
NCC2-333 ..... p 443 N86-33016
NIH-ES-00354 ..... p 418 A86-47873
NIH-GM-27057 ..... p 415 A86-50271
NIH-HD-16195 ..... p 426 A86-49521
NIH-HL-17731 ..... p 419 A86-47874
NIH-HL-17732 ..... p 418 A86-47873
NIH-HL-25984 ..... p 413 A86-47869
NIH-N01-HR-2915 ..... p 419 A86-47875
NIH-R01-HL-24335 ..... p 419 A86-47875
NIH-T32-ES-507086 ..... p 418 A86-47873
NIH-2-507-RR-05749 ..... p 418 A86-47870
NSF BNS-82-04811 ..... p 426 A86-49870
NSG-7151 ..... p 415 A86-50271
N00014-80-C-0505 ..... p 428 N86-32968
N00014-81-K-0136 ..... p 417 N86-32952
N00014-85-C-0594 ..... p 425 N86-32961
PHS-NS-10940 ..... p 414 A86-49871
PHS-RR-05425 ..... p 414 A86-49871
PHS-1-R01-NS22517-01 ..... p 417 N86-32952
STC-80-5/I ..... p 427 N86-32095
W-7405-ENG-48 ..... p 435 N86-32105
p 444 N86-33023
199-40-12 ..... p 417 N86-32950
199-61-12 ..... p 434 N86-32101
505-35-11 ..... p 436 N86-32976

### Typical Report Number Index Listing




Listings in this index are arranged alpha-numerically by report number. The page number indicates the page on which the citation is located. The accession number denotes the number by which the citation is identified. An asterisk (*) indicates that the item is a NASA report. A pound sign (#) indicates that the item is available on microfiche.


A-86218 ... p 436 N86-32976 * #
A-86233 ... p 417 N86-32950 * #

AAMRL-TR-85-062 ... p 443 N86-33019 #

AD-A167059 ... p 434 N86-32103 #
AD-A167397 ... p 434 N86-32104 #
AD-A167399 ... p 422 N86-32089 #
AD-A167408 ... p 416 N86-32084 #
AD-A167422 ... p 423 N86-32090 #
AD-A167426 ... p 427 N86-32098 #
AD-A167729 ... p 424 N86-32956 #
AD-A167738 ... p 423 N86-32091 #
AD-A167740 ... p 427 N86-32967 #
AD-A167783 ... p 428 N86-32968 #
AD-A167916 ... p 423 N86-32092 #
AD-A167947 ... p 424 N86-32957 #
AD-A167949 ... p 428 N86-32969 #
AD-A167958 ... p 428 N86-32970 #
AD-A168019 ... p 417 N86-32952 #
AD-A168240 ... p 428 N86-32971 #
AD-A168246 ... p 428 N86-32972 #
AD-A168250 ... p 424 N86-32958 #
AD-A168335 ... p 424 N86-32959 #
AD-A168485 ... p 443 N86-33019 #
AD-A168547 ... p 424 N86-32960 #
AD-A168563 ... p 443 N86-33020 #
AD-A168567 ... p 428 N86-32973 #
AD-A168568 ... p 429 N86-32974 #
AD-A168581 ... p 425 N86-32961 #
AD-A168630 ... p 425 N86-32962 #
AD-A168662 ... p 425 N86-32963 #
AD-A168733 ... p 417 N86-32953 #
AD-A168832 ... p 443 N86-33021 #
AD-A168850 ... p 444 N86-33022 #

AD-D012273 ... p 423 N86-32955 #
AD-D012299 ... p 443 N86-33017 #
AD-D012325 ... p 417 N86-32951 #
AD-D012339 ... p 443 N86-33018 #

AD-E900565 ... p 428 N86-32971 #

AFIT/CI/NR-86-38T ... p 434 N86-32103 #

AFOSR-86-0317TR ... p 429 N86-32974 #
AFOSR-86-0325TR ... p 428 N86-32973 #

AI-M-832 ... p 428 N86-32968 #

AIAA PAPER 86-2090 ... p 429 A86-47440 * #
AIAA PAPER 86-2185 ... p 429 A86-47467 #
AIAA PAPER 86-2252 ... p 426 A86-47498 #
AIAA PAPER 86-2300 ... p 434 A86-49552 * #
AIAA PAPER 86-2337 ... p 421 A86-49560 #

AMD-TR-86-001 ... p 423 N86-32090 #

AR-2 ... p 416 N86-32085 #

ARI-RN-85-103 ... p 427 N86-32967 #
ARI-RN-86-32 ... p 422 N86-32089 #
ARI-RN-86-33 ... p 434 N86-32104 #
ARI-RN-86-41 ... p 428 N86-32969 #

ASI-479-19-2 ... p 427 N86-32967 #

ASME PAPER 86-GT-296 ... p 433 A86-48309 #

BNL-37795 ... p 425 N86-32964 #

BR98339 ... p 415 N86-32082 #

B8661085 ... p 435 N86-32106 #

CAORF-16-8122-02 ... p 424 N86-32956 #

CONF-8603109-3 ... p 425 N86-32964 #
CONF-8604159-1 ... p 435 N86-32105 #

DE86-009402 ... p 435 N86-32105 #
DE86-009632 ... p 416 N86-32085 #
DE86-010287 ... p 416 N86-32086 #
DE86-010547 ... p 425 N86-32964 #
DE86-010561 ... p 444 N86-33023 #

DFVLR-FB-85-21 ... p 427 N86-32099 #
DFVLR-FB-85-40 ... p 416 N86-32087 #

DFVLR-MITT-86-01 ... p 429 N86-32975 #

DGLR-BERICHT 85-04 ... p 432 A86-47766 #

DOE/ER-10803/5 ... p 416 N86-32086 #
DOE/ER-13234/2 ... p 416 N86-32085 #

DRIC-T-7663 ... p 415 N86-32082 #

ESA-CR(P)-2190-PT-1 ... p 435 N86-32107 #
ESA-CR(P)-2190-PT-2 ... p 444 N86-33024 #
ESA-CR(P)-2190-PT-3 ... p 435 N86-32108 #
ESA-CR(P)-2190-PT-4 ... p 435 N86-32109 #
ESA-CR(P)-2190-PT-5 ... p 435 N86-32110 #

ESA-TT-944 ... p 427 N86-32099 #
ESA-TT-963 ... p 416 N86-32087 #

ETN-86-97263 ... p 415 N86-32082 #
ETN-86-97385 ... p 423 N86-32093 #
ETN-86-97386 ... p 423 N86-32094 #
ETN-86-97393 ... p 427 N86-32095 #
ETN-86-97533 ... p 425 N86-32965 #
ETN-86-97540 ... p 426 N86-32966 #
ETN-86-97579 ... p 427 N86-32099 #
ETN-86-97669 ... p 435 N86-32106 #
ETN-86-97768 ... p 423 N86-32954 #
ETN-86-97787 ... p 435 N86-32107 #
ETN-86-97788-PT-2 ... p 444 N86-33024 #
ETN-86-97789 ... p 435 N86-32108 #
ETN-86-97790 ... p 435 N86-32109 #
ETN-86-97791 ... p 435 N86-32110 #
ETN-86-97814 ... p 429 N86-32975 #
ETN-86-98043 ... p 427 N86-32100 #
ETN-86-98077 ... p 416 N86-32087 #

FAA/AM-86/3-PT-6 ... p 424 N86-32958 #
FAA/AM-86/4 ... p 428 N86-32971 #

FOK-TR-R-84-CHC-131-PT-2 ... p 444 N86-33024 #

FTD-ID(RS)T-0294-86 ... p 423 N86-32092 #

ISBN-90-6807-016-9 ... p 423 N86-32954 #

ISSN-0176-7739 ... p 429 N86-32975 #

ISVR-TR-133-PT-1 ... p 442 N86-33014 #
ISVR-TR-134 ... p 443 N86-33015 #

IZF-1985-19 ... p 427 N86-32100 #

MBB-LKE-301/S/PUB/216 ... p 432 A86-47771 #

NADC-86011-60 ... p 443 N86-33020 #

NAMRL-1315 ... p 424 N86-32960 #
NAMRL-1316 ... p 428 N86-32972 #
NAMRL-1318 ... p 417 N86-32953 #

NAS 1.15:88249 ... p 417 N86-32950 * #
NAS 1.21:7011(288) ... p 422 N86-32088 * #
NAS 1.26:177400 ... p 434 N86-32101 * #
NAS 1.26:179661 ... p 444 N86-32111 * #
NAS 1.26:179717 ... p 443 N86-33016 * #
NAS 1.26:3922(08) ... p 416 N86-32083 * #
NAS 1.55:2428 ... p 436 N86-32976 * #

NASA-CP-2428 ... p 436 N86-32976 * #

NASA-CR-177400 ... p 434 N86-32101 * #
NASA-CR-179661 ... p 444 N86-32111 * #
NASA-CR-179717 ... p 443 N86-33016 * #
NASA-CR-3922(08) ... p 416 N86-32083 * #

NASA-SP-7011(288) ... p 422 N86-32088 * #

NASA-TM-88249 ... p 417 N86-32950 * #

NCSC-TM-4110-2-85 ... p 444 N86-33022 #

NF-150/1-86 ... p 434 N86-32102 * #

NLR-MP-85020-U ... p 435 N86-32106 #

NLR-TR-84116-L-PT-1 ... p 435 N86-32107 #
NLR-TR-84116-L-PT-2 ... p 444 N86-33024 #
NLR-TR-84116-L-PT-3 ... p 435 N86-32108 #
NLR-TR-84116-L-PT-4 ... p 435 N86-32109 #
NLR-TR-84116-L-PT-5 ... p 435 N86-32110 #

PFTR-1126-85-11 ... p 428 N86-32973 #

PIR-1126-85-4 ... p 429 N86-32974 #

RADC-TR-85-265 ... p 427 N86-32098 #

SAR-1 ... p 443 N86-33016 * #

STC-TM-749 ... p 427 N86-32095 #

TDCK-93575 ... p 427 N86-32100 #

TR-29 ... p 417 N86-32952 #

UCRL-15688 ... p 444 N86-33023 #
UCRL-94415 ... p 435 N86-32105 #

US-PATENT-APPL-SN-585092 ... p 423 N86-32955 #
US-PATENT-APPL-SN-612776 ... p 417 N86-32951 #
US-PATENT-APPL-SN-688944 ... p 443 N86-33018 #
US-PATENT-APPL-SN-788371 ... p 443 N86-33017 #

US-PATENT-CLASS-128-202.12 ... p 417 N86-32951 #
US-PATENT-CLASS-351-243 ... p 423 N86-32955 #
US-PATENT-CLASS-362-62 ... p 443 N86-33018 #

US-PATENT-4,572,630 ... p 423 N86-32955 #
US-PATENT-4,580,196 ... p 443 N86-33018 #
US-PATENT-4,582,055 ... p 417 N86-32951 #

USAARL-86-1 ... p 416 N86-32084 #

USAFSAM-TP-85-6 ... p 428 N86-32970 #

USAFSAM-TR-85-102 ... p 443 N86-33021 #

USARIEM-M-28/86 ... p 423 N86-32091 #
USARIEM-M-32/86 ... p 425 N86-32963 #

USARIEM-M27/86 ... p 424 N86-32957 #
USARIEM-M33/86 ... p 425 N86-32962 #

VK-84-10 ..... p 423 N86-32954 #

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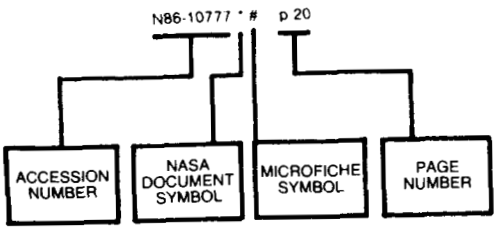


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A86-47440 * # p 429
A86-47467 # p 429
A86-47498 # p 426
A86-47726 # p 429
A86-47729 # p 417
A86-47732 # p 430
A86-47734 # p 430
A86-47735 # p 430
A86-47737 # p 430
A86-47739 # p 430
A86-47740 # p 430
A86-47741 * # p 417
A86-47742 # p 430
A86-47746 # p 431
A86-47747 # p 431
A86-47749 # p 431
A86-47751 # p 431
A86-47752 # p 431
A86-47753 # p 418
A86-47754 # p 418
A86-47761 # p 431
A86-47762 # p 432
A86-47764 # p 432
A86-47765 * # p 418
A86-47766 # p 432
A86-47767 # p 432
A86-47770 # p 432
A86-47771 # p 432
A86-47772 # p 433
A86-47773 # p 433
A86-47774 # p 433
A86-47775 # p 433
A86-47868 # p 418
A86-47869 # p 413
A86-47870 # p 418
A86-47871 * # p 413
A86-47872 * # p 413
A86-47873 # p 418
A86-47874 # p 419
A86-47875 # p 419
A86-48309 # p 433
A86-48553 # p 433
A86-48713 * # p 433
A86-49155 # p 413
A86-49225 * # p 419
A86-49250 * # p 419
A86-49263 # p 419
A86-49264 # p 419
A86-49265 # p 420
A86-49266 # p 420
A86-49267 # p 420
A86-49268 # p 420
A86-49269 # p 420
A86-49270 # p 420
A86-49271 # p 421
A86-49272 # p 421
A86-49273 # p 421
A86-49339 # p 421
A86-49345 # p 413
A86-49346 # p 413
A86-49347 # p 414
A86-49348 # p 414
A86-49367 # p 414
A86-49368 # p 414
A86-49370 # p 421
A86-49371 # p 426
A86-49521 * # p 426
A86-49523 * # p 421
A86-49524 * # p 414
A86-49552 * # p 434
A86-49560 # p 421
A86-49633 * # p 426
A86-49634 * # p 434
A86-49636 * # p 422
A86-49870 * # p 426
A86-49871 * # p 414
A86-49919 # p 422
A86-49920 # p 422
A86-49921 # p 414
A86-49975 # p 422
A86-49998 # p 415
A86-49999 * # p 415
A86-50271 * # p 415
A86-50283 * # p 427
A86-50288 # p 415
A86-50289 # p 415
A86-50290 # p 415
N86-32082 # p 415
N86-32083 * # p 416
N86-32084 # p 416
N86-32085 # p 416
N86-32086 # p 416
N86-32087 # p 416
N86-32088 * # p 422
N86-32089 # p 422
N86-32090 # p 423
N86-32091 # p 423
N86-32092 # p 423
N86-32093 # p 423
N86-32094 # p 423
N86-32095 # p 427
N86-32096 # p 427
N86-32097 # p 427
N86-32098 # p 427
N86-32099 # p 427
N86-32100 # p 427
N86-32101 * # p 434
N86-32102 * # p 434
N86-32103 # p 434
N86-32104 # p 434
N86-32105 # p 435
N86-32106 # p 435
N86-32107 # p 435
N86-32108 # p 435
N86-32109 # p 435
N86-32110 # p 435
N86-32111 * # p 444
N86-32950 * # p 417
N86-32951 # p 417
N86-32952 # p 417
N86-32953 # p 417
N86-32954 # p 423
N86-32955 # p 423
N86-32956 # p 424
N86-32957 # p 424
N86-32958 # p 424
N86-32959 # p 424
N86-32960 # p 424
N86-32961 # p 425
N86-32962 # p 425
N86-32963 # p 425
N86-32964 # p 425
N86-32965 # p 425
N86-32966 # p 426
N86-32967 # p 427
N86-32968 # p 428
N86-32969 # p 428
N86-32970 # p 428
N86-32971 # p 428
N86-32972 # p 428
N86-32973 # p 428
N86-32974 # p 429
N86-32975 # p 429
N86-32976 * # p 436
N86-32977 * # p 436
N86-32978 * # p 436
N86-32979 * # p 436
N86-32980 * # p 436
N86-32981 * # p 436
N86-32982 * # p 437
N86-32983 * # p 437
N86-32984 * # p 437
N86-32985 * # p 437
N86-32986 * # p 437
N86-32987 * # p 438
N86-32988 * # p 438
N86-32989 * # p 438
N86-32990 * # p 438
N86-32991 * # p 438
N86-32992 * # p 439
N86-32993 * # p 439
N86-32994 * # p 439
N86-32995 * # p 439
N86-32996 * # p 439
N86-32997 * # p 439
N86-32998 * # p 440
N86-32999 * # p 440
N86-33000 * # p 440
N86-33001 * # p 440
N86-33002 * # p 440
N86-33003 * # p 441
N86-33004 * # p 441
N86-33005 * # p 441
N86-33006 * # p 441
N86-33007 * # p 441
N86-33008 * # p 441
N86-33009 * # p 442
N86-33010 * # p 442
N86-33011 * # p 442
N86-33012 * # p 442
N86-33013 * # p 442
N86-33014 # p 442
N86-33015 # p 443
N86-33016 * # p 443
N86-33017 # p 443
N86-33018 # p 443
N86-33019 # p 443
N86-33020 # p 443
N86-33021 # p 443
N86-33022 # p 444
N86-33023 # p 444
N86-33024 # p 444

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